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FETAL IMAGING

Magnetic resonance imaging of the fetal gastrointestinal system

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Abstract

In this paper the authors review the normal imaging appearance of the fetal gastrointestinal tract and patterns of fetal gastrointestinal tract obstruction. The authors include a detailed summary from esophagus to the rectum, including the expected pattern of meconium and small-bowel contents at different gestational ages. Common fetal gastrointestinal tract obstructions are reviewed with accompanying case examples, emphasizing the role of the meconium and bowel-caliber patterns in establishing differential diagnoses. This review also includes imaging pitfalls, complications of gastrointestinal tract obstruction, and implications for patient care.

Keywords Abdomen · Bowel obstruction · Fetus · Gastrointestinal tract · Magnetic resonance imaging · Meconium

Introduction

Fetal MRI is particularly useful in cases of bowel obstruction identified on the fetal US examination. The large field of view of MRI allows for visualization of the extent and pattern of dilated bowel loops. Importantly, meconium is T1 hyperintense, allowing T1 sequences to serve as a "fetal enema." This fetal enema allows for visualization and identification of the location of the meconium as well as the caliber of the colon, information that can narrow the differential diagnosis in a gastrointestinal tract obstruction. Recognition of the normal MRI appearance of the gastrointestinal tract, including the meconium patterns, at every gestational age allows for identification and accurate diagnosis of abnormalities. The diagnosis can impact parent counseling, delivery planning, postnatal care plan, preoperative planning and patient outcomes.

Normal appearance of the fetal gastrointestinal tract

The digestive tract begins to develop in the third week of gestation and is complete by the early to mid-second trimester [1]. The anterior gut forms the pharyngeal membrane through the second part of the duodenum. The midgut forms the duodenum distal to the bile duct through the distal third of the transverse colon. This portion of the bowel develops outside the peritoneal cavity during the 6th–10th gestational weeks. The hindgut forms the left colon to the rectum [1].

Esophagus and stomach

The esophagus appears as a column of T2 hyperintensity extending from the pharynx to the stomach if imaged during a fetal swallow, which begins to occur at approximately 14 weeks of gestation [2]. When imaging is not obtained during a swallow, the esophagus will not be distended with fluid and thus not well seen. Therefore, non- or partial visualization of the esophagus does not necessarily indicate pathology. Thick-slab sagittal T2-weighted MR images might be helpful in visualizing the esophageal fluid column, particularly in cases with concern for esophageal atresia (Fig. 1). Additionally, cine or dynamic slabs can be helpful when evaluating for swallowing and presence of an esophageal pouch.

After 18 weeks of gestation, when fetal swallowing has been well established, the stomach should be fluid-filled, T2 hyperintense, and identifiable in the left upper quadrant on MRI [2].

Small bowel, colon and rectum

Meconium begins to form in the first trimester and is a combination of biliary and intestinal gland secretions. The T1-hyperintense signal of meconium is caused by the protein,

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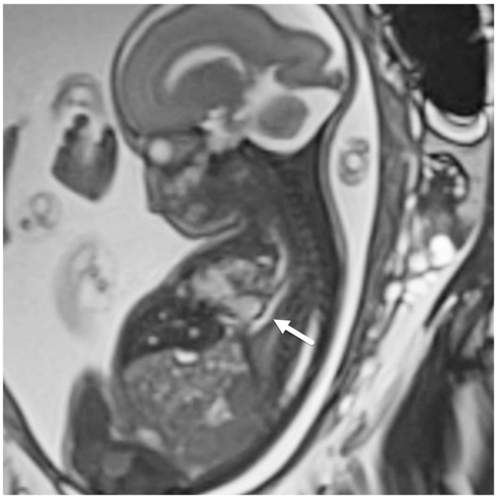


Fig. 1 The normal esophagus in a fetus at 28 weeks 1 day of gestation. Sagittal balanced steady-state free precession (bSSFP) MR image demonstrates the thin T2-hyperintense esophagus (*arrow*)

copper, iron and manganese contents, resulting in the "fetal enema" appearance on MRI [3] (Fig. 2). As gestation advances, meconium, desquamated epithelium and amniotic fluid migrate from the small bowel to the rectum. This results in differing appearances of the intraluminal content of the small bowel and colon at different gestational ages.

We will discuss the appearance of the small-bowel contents first. Late in the second trimester (Weeks 24–25), the previously collapsed, internally T2-hypo- or isointense small-bowel loops begin to increase in size, ranging 2–7 mm in diameter [2, 4]. After this time, the small bowel becomes readily visible on T2-weighted imaging secondary to increased volume of swallowed amniotic fluid and increased gastric emptying [2]. Up to 30 weeks of gestation, the distal half of the small bowel shows T1-hyperintense meconium signal, reflecting the continued transit of meconium through the bowel and resorption of fluid in the distal small bowel [2, 4]. Late in the third trimester, the small bowel is entirely fluid-filled and T2 hyperintense because of the accumulation of swallowed amniotic fluid and the transit of meconium into the colon [4] (Fig. 3).

The imaging signal characteristics of the colon are also dependent upon gestational age. At 20 weeks of gestation, the splenic flexure and descending colon are in the expected anatomical position. The ascending colon and transverse colon form a diagonal from the right iliac crest to the left upper quadrant, with final anatomical position of the hepatic flexure achieved in the third trimester [2]. The colonic diameter increases in size with age, measuring 3–4 mm at 20 weeks of gestation and 8–15 mm at term [5]. T1-hyperintense meconium signal is first identified in the rectum at 20 weeks of gestation. The meconium accumulates and extends proximally throughout the colon as gestation advances. By 24 weeks of gestation, the descending colon should be filled with meconium, and by 25 weeks, 90% of fetuses have meconium throughout the entire colon [6]. Of note, 10% of normal fetuses do not have meconium in the right colon until 32 weeks of gestation [4] (Fig. 4).

At 20 weeks of gestation, T1-hyperintense meconium signal should be identified in the rectum following functional closure of the anal canal [7]. The rectum should extend at least 1 cm below the bladder neck to exclude anorectal malformations. The diameter of the rectum increases with gestational age and should measure 4–8 mm at 24 weeks of gestation and 9–15 mm at 35 weeks of gestation [7, 8] (Fig. 4).

In summary, the expected pattern of fluid and meconium within the bowel varies by gestational age on MRI. At 20 weeks, meconium should be identified in the rectum. At 24 weeks, the descending colon should be filled with meconium. By 25 weeks, meconium is identified throughout the colon in 90% fetuses. Prior to 30 weeks, half of the distal small bowel is filled with meconium. Late in the third trimester, the entire small bowel is fluid-filled (Table 1).

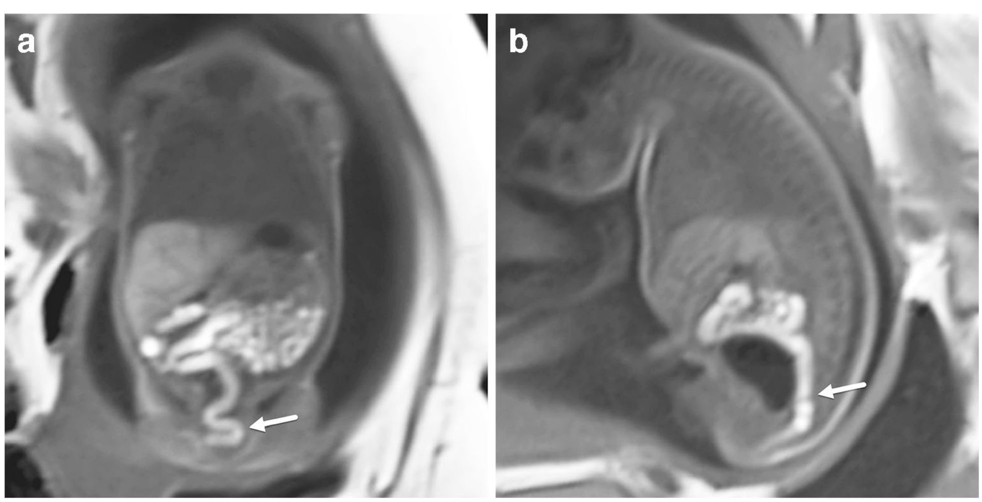


Fig. 2 Normal colonic meconium in a fetus at 28 weeks 1 day of gestation. **a**, **b** Coronal (**a**) and sagittal (**b**) T1-W volumetric interpolated breath-hold examination (VIBE) MR images demonstrate normal colonic meconium (*arrows*)

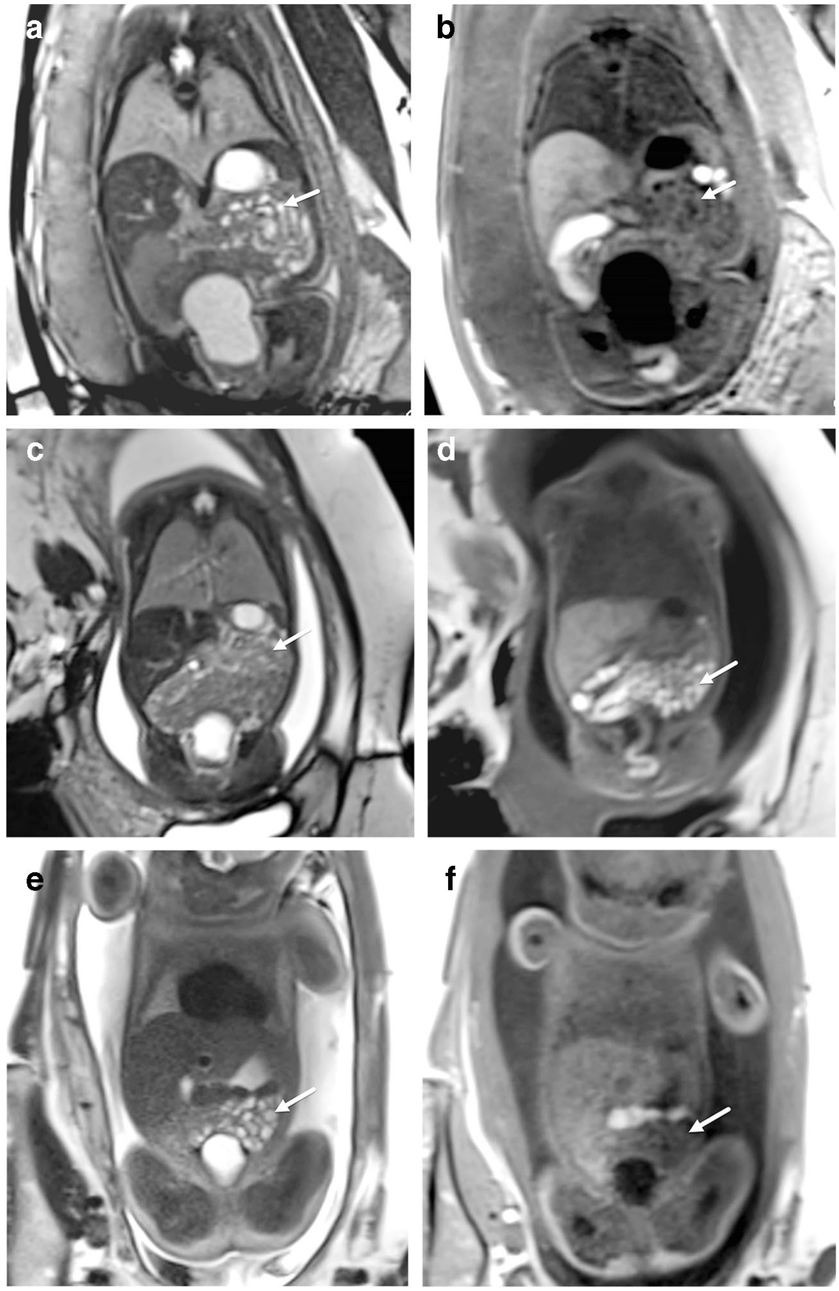


Fig. 3 Normal small bowel in fetuses at various stages. **a**, **b** MRI in a 20-week fetus. Coronal balanced steady-state free precession (bSSFP) (**a**) and T1-W volumetric interpolated breath-hold examination (VIBE) (**b**) MR images show the minimally fluid-filled small bowel (*arrows*) with minimal T1-hyperintense meconium signal within the distal small-bowel loops. **c**, **d** MR images in a 28-week fetus show normal small bowel (*arrows*) on coronal bSSFP (**c**) and T1-W VIBE (**d**). Note the increasing fluid distension and increasing T1-hyperintense meconium signal. **e**, **f** Imaging in a 34-week fetus shows normal small bowel (*arrows*) on coronal half-Fourier acquisition single-shot fast spin echo (HASTE) (**e**) and T1-W VIBE (**f**) MR images. Note the persistent fluid-filling of the small bowel loops and absent T1-hyperintense meconium signal (*arrows*)

Fetal gastrointestinal tract obstruction

The MR imaging appearance of gastrointestinal tract obstruction depends on the level of obstruction, the presence of atresias or other anomalies, and gestational age. MR imaging patterns of common fetal gastrointestinal tract obstructions and their complications are reviewed in the next sections.

Esophageal atresia

Esophageal atresia might be suggested on fetal US imaging in cases with a small or nonvisualized stomach, particularly in the setting of polyhydramnios. MRI provides increased accuracy in the diagnosis of esophageal atresia and can confirm a contracted stomach [4]. A dilated proximal esophageal pouch might be seen on MRI but remains challenging in many cases. If identified, a dilated esophageal pouch is 80% sensitive and 100% specific for esophageal atresia [9]. MRI remains poor at predicting an associated tracheoesophageal fistula [9]. Additionally, in the setting of esophageal atresia, there should be a careful search for other anomalies in the VACTERL (vertebral anomaly, anorectal malformation, cardiac disease, trachea-esophageal fistula, renal anomalies, limb anomalies) association. It is important to note the possible presence of

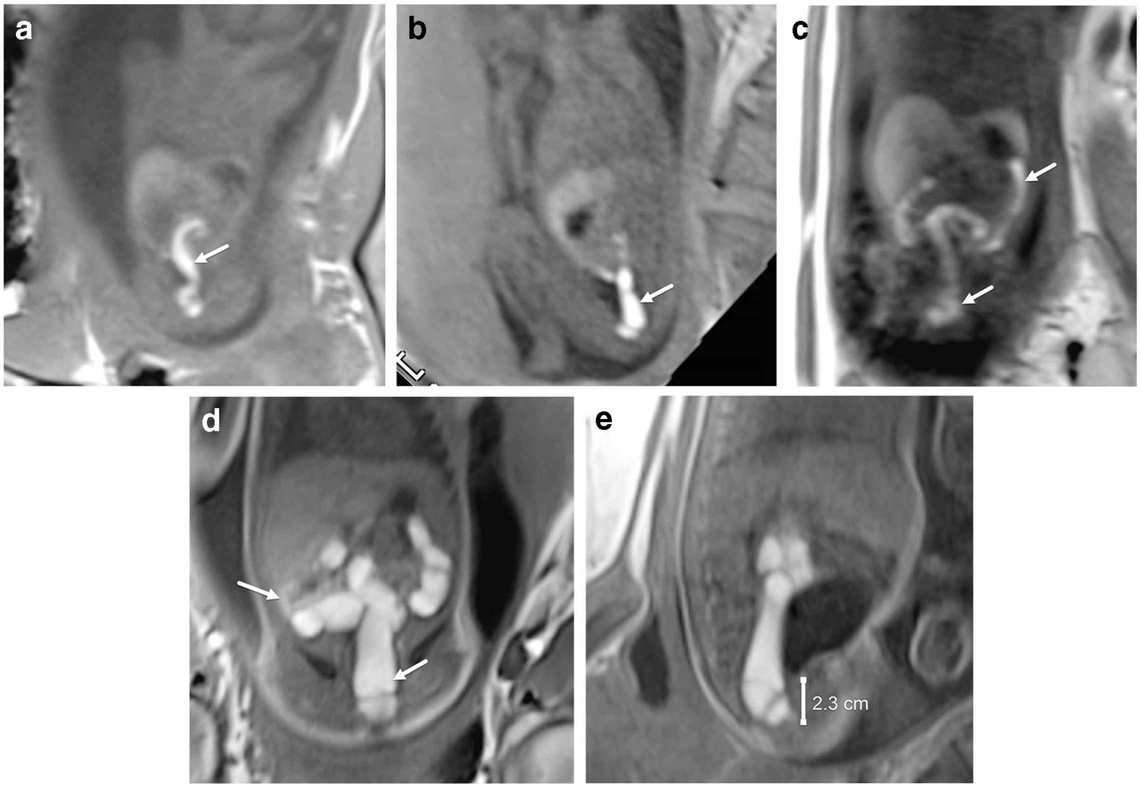


Fig. 4 Normal meconium in the fetal rectum at different stages. **a**, **b** Imaging in a 20-week fetus shows normal meconium in the rectum (*arrows*) on coronal T1-W (**a**) and sagittal T1-W volumetric interpolated breath-hold examination (VIBE) (**b**). **c** MRI in a 24-week fetus shows normal meconium in the descending colon and rectum (*arrows*) on coronal T1-W VIBE MR image. **d**, **e** Imaging in a 36-week fetus shows normal meconium throughout the entirety of the colon (*arrows*) on coronal (**d**) and sagittal (**e**) T1-W VIBE MR images. The rectal column extends 2.3 cm below the base of the bladder

multiple atresias in which the stomach might appear normal or even dilated in the setting of esophageal atresia if a proximal small-bowel atresia is also present [4] (Fig. 5).

Duodenal atresia

The classic fetal US findings of duodenal atresia, including polyhydramnios and double bubble, are similar on fetal MRI (Fig. 6). MRI might aid with evaluation in atypical cases and when other anomalies are identified on US imaging. Because duodenal atresia is associated with Trisomy 21 in up to 33% of cases and also the VACTERL association, fetal MRI can be useful for detecting and characterizing these associated abnormalities. MRI can also differentiate duodenal atresia from less common causes of fetal gastric outlet obstruction such as enteric duplication cyst and pyloric atresia. A normal colonic caliber and meconium distribution is expected in a proximal gastrointestinal obstruction. A lack of colonic meconium or

Table 1 MRI appearance of small bowel, colon and rectum throughout gestation

	20 weeks	24 weeks	25 weeks	30 weeks	Late third trimester
Rectum	Meconium	Meconium	Meconium	Meconium	Meconium
Descending colon		Meconium	Meconium	Meconium	Meconium
Ascending/ transverse colon			Meconium[a]	Meconium[a]	Meconium
Distal small bowel	50% distal small bowel with high T1 meconium	50% distal small bowel with high T1 meconium	50% distal small bowel with high T1 meconium	50% distal small bowel with high T1 meconium	Fluid-filled
Proximal small bowel	Collapsed with minimal fluid	Collapsed with minimal fluid	Fluid-filled	Fluid-filled	Fluid-filled

[a] 10% of fetuses do not have meconium in ascending colon until 32 weeks of gestation

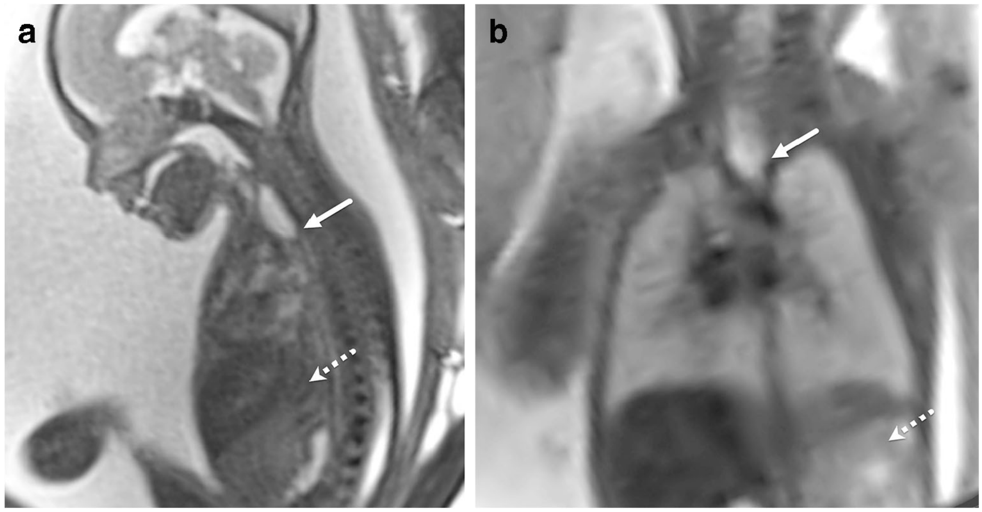


Fig. 5 Esophageal atresia in a 28-week gestation fetus. **a**, **b** Sagittal (**a**) and coronal (**b**) balanced steady-state free precession (bSSFP) MR images show polyhydramnios, dilated proximal esophageal pouch (*solid arrows*) and absent stomach (*dotted arrows*)

presence of a microcolon in the setting of a dilated stomach or small bowel should raise concern for multiple atresias [4] (Fig. 7).

Small-bowel atresia

Jejunal and ileal atresias are the most common sites of intestinal atresias, present in up to 1 in 1,500 births [10]. The pathophysiology has been described as an interruption to mesenteric blood supply after the 12th week of gestation [4]. Fetal US imaging demonstrates dilated loops of bowel and possibly polyhydramnios, particularly if the obstruction is more proximal. MRI additionally allows for characterizing the intraluminal contents of the dilated loops of bowel and detecting a microcolon. The signal of the intraluminal contents can aid in differentiating proximal versus distal small-bowel obstruction. In a proximal small-bowel obstruction, such as jejunal atresia, the dilated loops of bowel should have T2-hyperintense and T1-hypointense signal. In a distal small-bowel obstruction, such as ileal atresia, the dilated loops of bowel typically contain T1-hyperintense and T2-intermediate meconium signal. It is crucial to remain mindful of gestational age when evaluating for obstruction because the size of the colon, signal intensity within the bowel, and position of meconium within will progress over time, as detailed in a prior section [4] (Fig. 8).

Meconium ileus

The MRI appearance of uncomplicated meconium ileus can be similar to that of ileal atresia, with dilated loops of small bowel containing T1-hyperintense and T2-intermediate meconium signal and a microcolon. Meconium ileus is most commonly associated with cystic fibrosis and might present initially with fetal echogenic bowel on US imaging. Although fetal echogenic bowel is nonspecific and the majority of cases regress on follow-up US imaging, cystic fibrosis occurs in approximately 2% [11]. Complicated meconium ileus entails

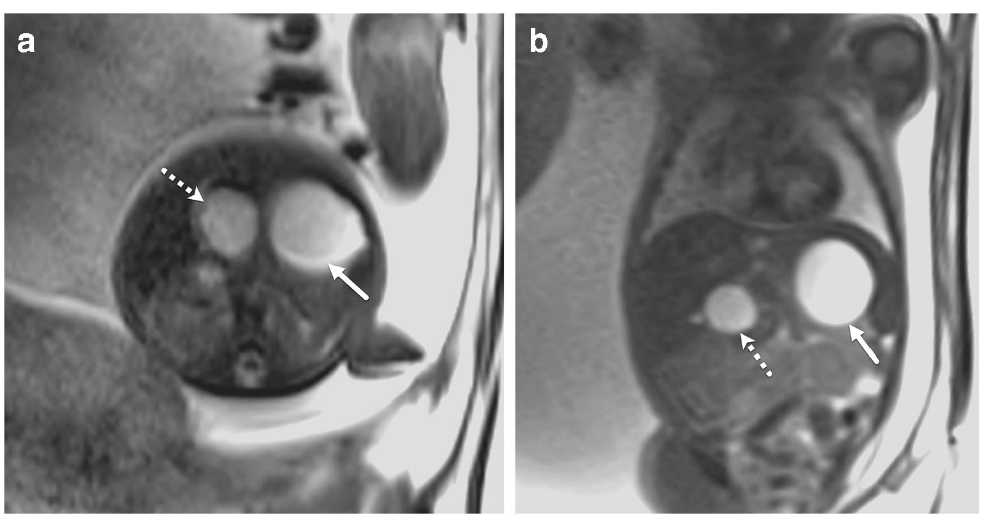


Fig. 6 Duodenal atresia in a 32-week gestation fetus. **a**, **b** Axial (**a**) and coronal (**b**) balanced steady-state free precession (bSSFP) MR images show a double-bubble appearance representing the dilated stomach (*solid arrows*) and proximal duodenum (*dotted arrows*)

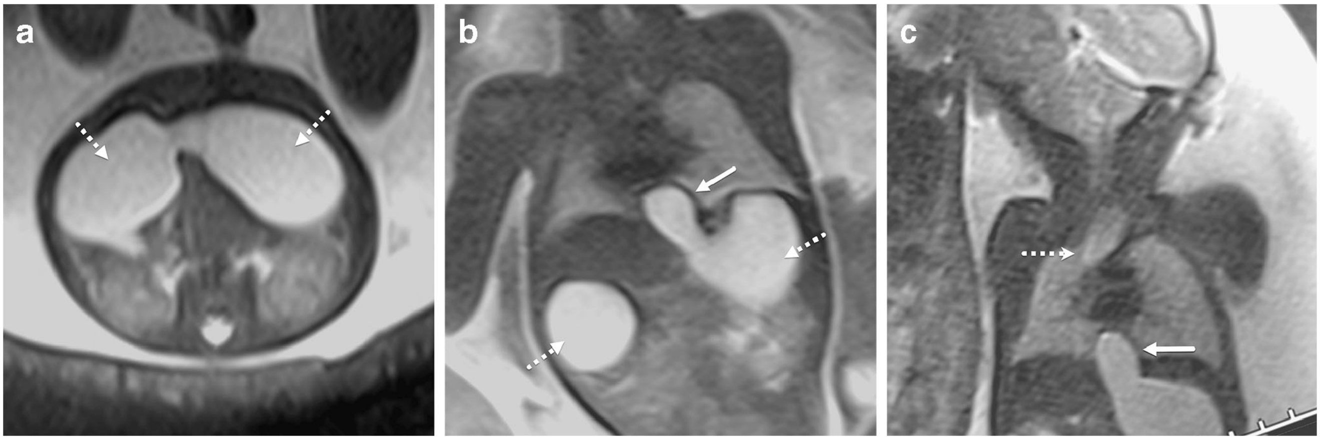


Fig. 7 Concurrent esophageal atresia without fistula (Type A) and duodenal atresia in a 28-week gestation fetus. **a–c** Axial (**a**) and coronal (**b** and **c**) balanced steady-state free precession (bSSFP) MR images show a double-bubble appearance representing dilated stomach and proximal duodenum (*dotted arrows* in **a** and **b**); however, also note the upstream dilation of the distal esophagus (*solid arrows*). There is also distention of the distal esophageal pouch (*dotted arrows* in **c**)

additional pathology such as perforation or volvulus, which might impact the timing of delivery. Thus, identification of complications is essential for appropriate patient care. Additional imaging findings beyond microcolon can raise concern for such complications. One finding is a gradient appearance of fluid-fluid signal with transition from T2-hypointense to T2-hyperintense signal within a single dilated loop, suggesting stasis and complete obstruction [12]. The second finding raising concern for complicated meconium ileus is focal, localized meconium, which might be extraluminal, within a pseudocyst, or intraluminal within a closed, obstructed loop [12].

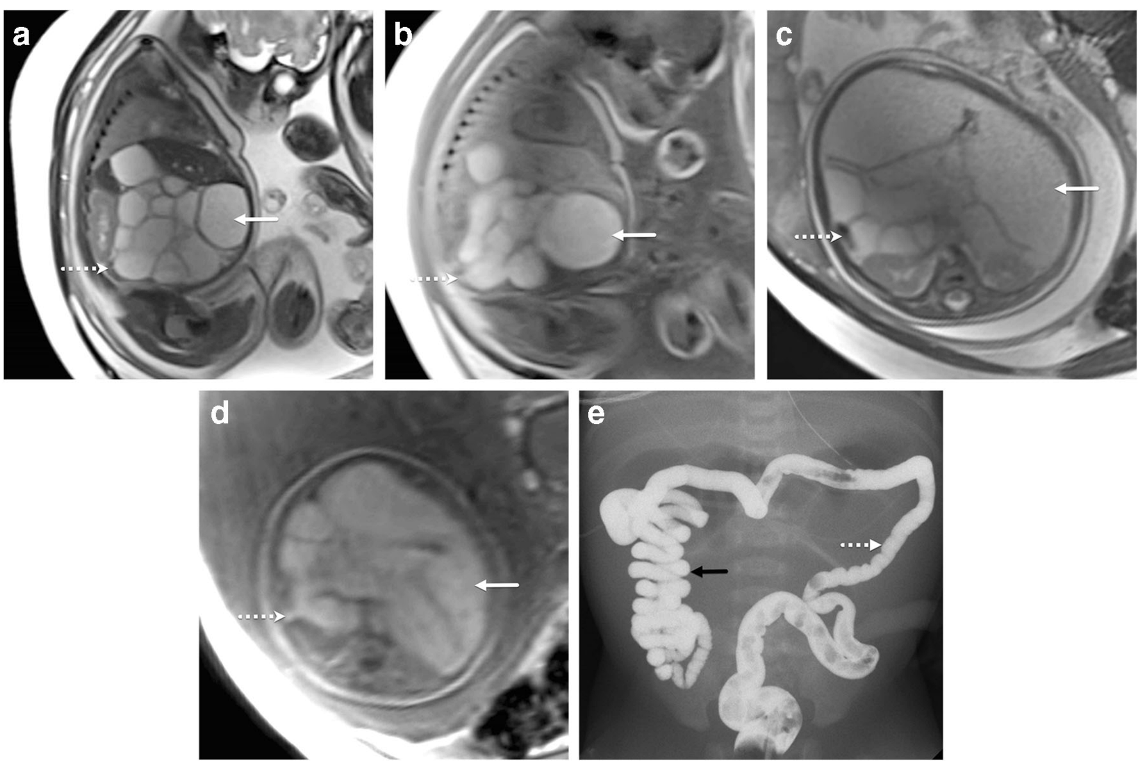


Fig. 8 Small-bowel atresia in a 37-week gestation female fetus. **a–d** Sagittal balanced steady-state free precession (bSSFP) (**a**), sagittal T1-W volumetric interpolated breath-hold examination (VIBE) (**b**), axial bSSFP (**c**) and axial T1-W spoiled-gradient echo (**d**) MR images show dilated loops of small bowel (*solid arrows*), which demonstrate T1-hyperintense meconium signal and mildly T2-hyperintense signal, compatible with distal small bowel. Also note the microcolon (*dotted arrow*). **e** A water-soluble enema performed at Day 1 of age demonstrates a microcolon (*white arrow*) with an apple-core configuration of the distal small bowel (*black arrow*), compatible with a Type IIIb jejunal atresia

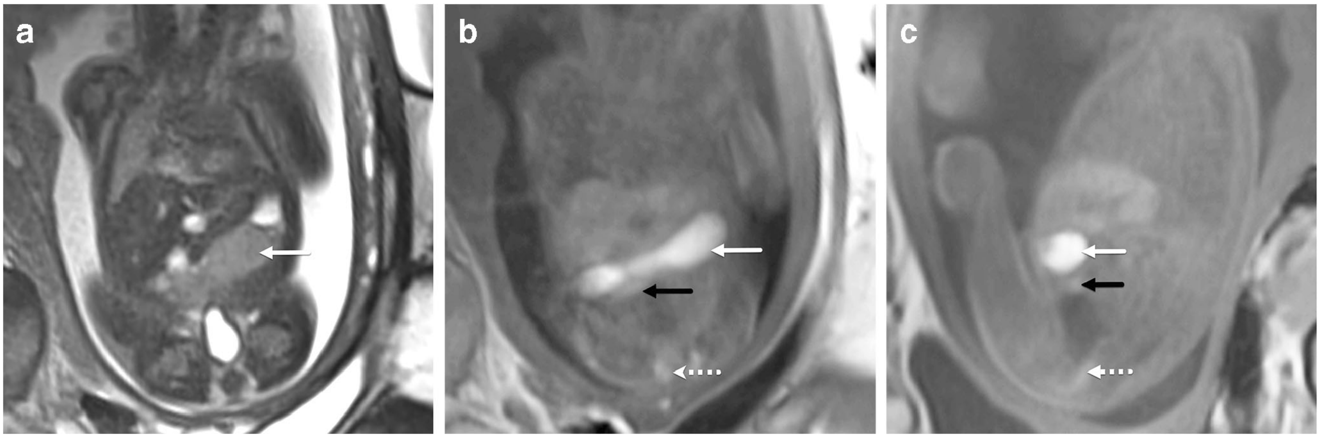


Fig. 9 Colonic obstruction in a 28-week gestation fetus with atresia of the distal ileum, cecum, right colon and part of the transverse colon. **a** Coronal balanced steady-state free precession (bSSFP) MR image demonstrates dilated distal small-bowel loops with T2-hypointensity (*arrow*). **b** Coronal T1-W volumetric interpolated breath-hold examination (VIBE) MR image demonstrates T1-hyperintense meconium in the rectum (*white dotted arrows*), microcolon (*black arrows*), and dilated meconium-filled distal small-bowel loops (*white solid arrows*). **c** Sagittal T1-W VIBE image shows the same

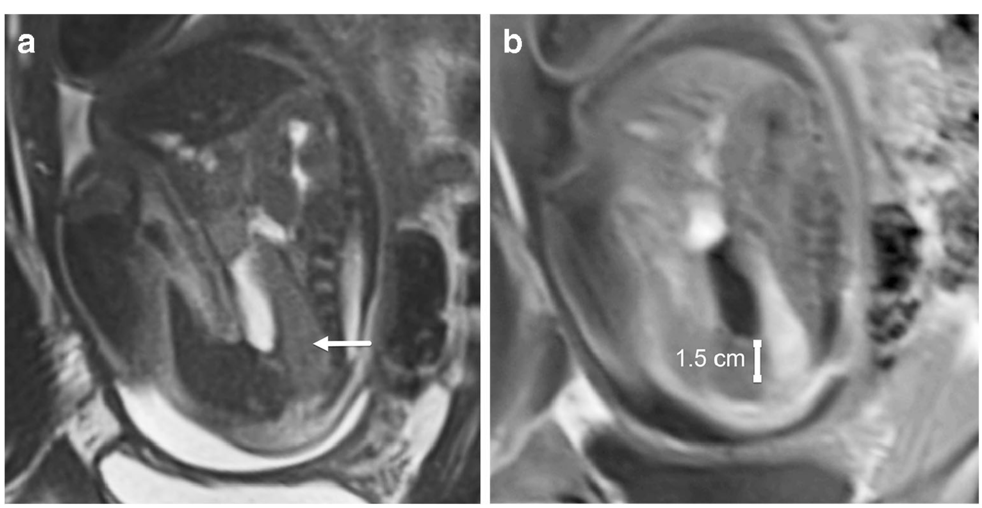
Although the presence of a microcolon most likely indicates a small-bowel obstruction, such as atresia or meconium ileus, megacystis microcolon hypoperistalsis syndrome (MMHS) might also present with a microcolon. This rare syndrome is an autosomal-recessive disorder, more commonly observed in females. It results in impaired muscular contractions and peristalsis of the gastrointestinal and genitourinary tracts. MMHS might present with a microcolon in utero but should also demonstrate a markedly distended urinary bladder [13, 14].

Colonic obstruction

Colonic obstruction can result from anorectal malformations, colonic atresia or Hirschsprung disease (Fig. 9). Cloacal malformations can also result in colonic obstruction but are not included in this discussion.

Of the anorectal malformations, anal atresia is most common, occurring in as many as 1 in 2,000 births [15]. Although 33% of anorectal malformations are isolated, they are commonly seen in the setting of syndromes and the VACTERL association [16]. Fetuses with anorectal malformations have decreased survival compared to other types of small-bowel and colonic obstruction, presumably because of the high incidence of comorbidities [17]. Given that anorectal malformations typically demonstrate a normal colon caliber, the diagnosis can be challenging on prenatal imaging, with detection rates as low as 8% [18] (Fig. 10). A dilated rectum is seen in some cases but is nonspecific [4]. As previously described, T1-hyperintense meconium should be present in the rectum after 20 weeks of gestation. Absent or scant rectal meconium after 20 weeks of gestation is abnormal. The rectal meconium column should extend at least 1 cm inferior to the urinary bladder base; if this measures less than 1 cm, the

Fig. 10 Anorectal malformation in a 35-week gestation fetus imaged for a closed neural tube defect, with an unremarkable rectum measuring 11.5 mm in diameter (normal is 9–15 mm at this gestational age). **a**, **b** The rectal column measured 1.5 cm below the base of the bladder, as demonstrated on sagittal balanced steady-state free precession (bSSFP) (**a**) (*arrow*) and sagittal T1-W volumetric interpolated breath-hold examination (VIBE) (**b**) MR images. The infant was found to have imperforate anus after birth



presence of an anorectal malformation is suggested [19]. In the presence of a rectourethral fistula, the rectum might be filled with fluid of heterogeneous signal as urine from the fetal bladder fills the rectum. The mixing of urine with meconium often results in intraluminal calcifications (enteroliths) [20] (Fig. 11).

Other conditions that sometimes diminish the rectal meconium signal include combined small-bowel and colonic obstructions, cystic fibrosis, impaired fetal swallowing and neurogenic bowel [8, 21]. Although uncommon, congenital secretory diarrhea should be considered in the setting of absent rectal meconium; however, diffuse distension of the small and large bowel will also be present [22].

Imaging pitfalls

Imaging of gastrointestinal tract obstruction can be challenging and the fetal imager must be aware of the following possible imaging pitfalls.

Polyhydramnios, which is commonly seen in esophageal and duodenal atresia, might not be seen in more distal bowel obstructions because the proximal small bowel might be sufficient in length to absorb the swallowed amniotic fluid.

The variable quality of T1-W imaging sequences can lead to false-positive exams because of apparently/falsely absent meconium. With regard to colon and rectal size, the appearance of a microcolon can be transient, the mechanism of which is not clearly understood [23]. Additionally, a large urinary bladder might compress the rectum and result in a falsely narrowed rectal meconium column. A mildly dilated rectum is nonspecific and might not indicate the presence of an anorectal malformation [4].

Complications and outcomes

Complications of fetal gastrointestinal tract obstruction include bowel perforations, meconium peritonitis, meconium pseudocyst, volvulus and ischemia/infarct of the bowel. The presence of dilated bowel loops, ascites or abdominal cysts on US or MR imaging should raise suspicion for complications. MRI might demonstrate T1-hyperintense meconium signal in the ascites or pseudocyst. Additional imaging, including gradient echo (GRE) and T2* sequences, allows for increased specificity of diagnosis with visualization of calcifications within the peritoneum or wall of the pseudocyst [12] (Fig. 12). Of note, some children with evidence of in utero bowel perforation can be successfully treated postnatally with nonoperative, conservative management [24].

The large field of view available with MRI compared to US imaging might allow for observing the pattern of dilated

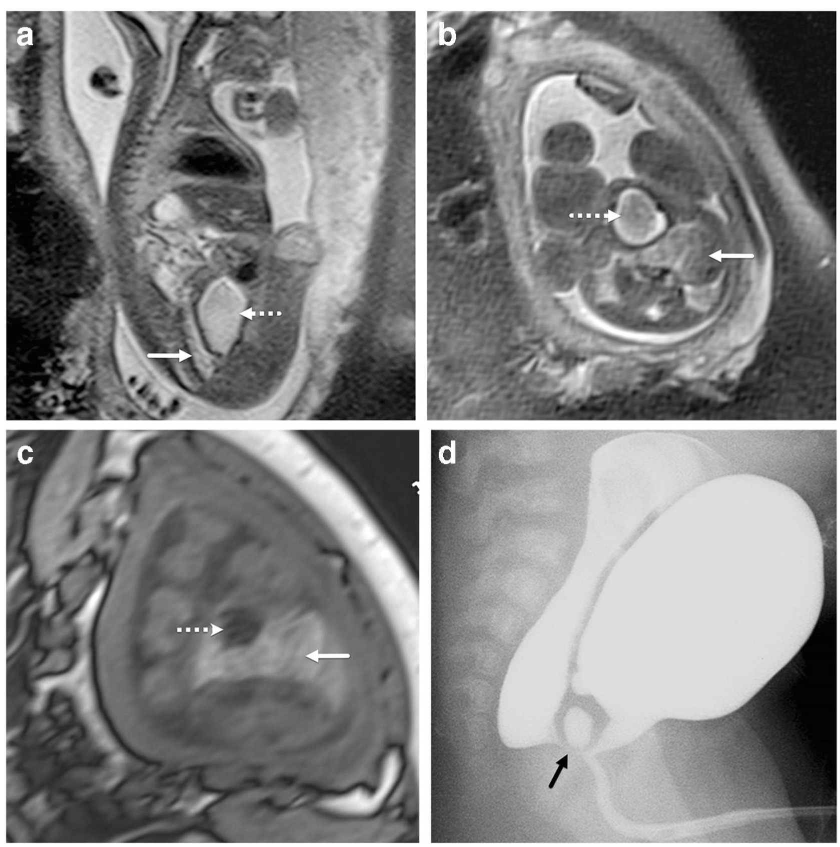


Fig. 11 Imperforate anus and rectourethral fistula in a 27-week gestation male fetus. **a**, **b** Sagittal (**a**) and axial (**b**) half-Fourier acquisition single-shot fast spin echo (HASTE) MR images demonstrate a dilated rectum with increased fluid signal within the rectum (*solid arrows*) and decreased fluid signal within the urinary bladder (*dotted arrows*). **c** Axial T1-W volumetric interpolated breath-hold examination (VIBE) MR image demonstrates less signal than would be expected for meconium (*solid arrows*). This appearance is caused by the mixing of urine and meconium via the rectourethral fistula. The urinary bladder is identified by the *dotted arrows*. **d** Postnatal imaging from a fluoroscopic voiding cystourethrogram demonstrates imperforate anus with rectourethral fistula (*arrow*)

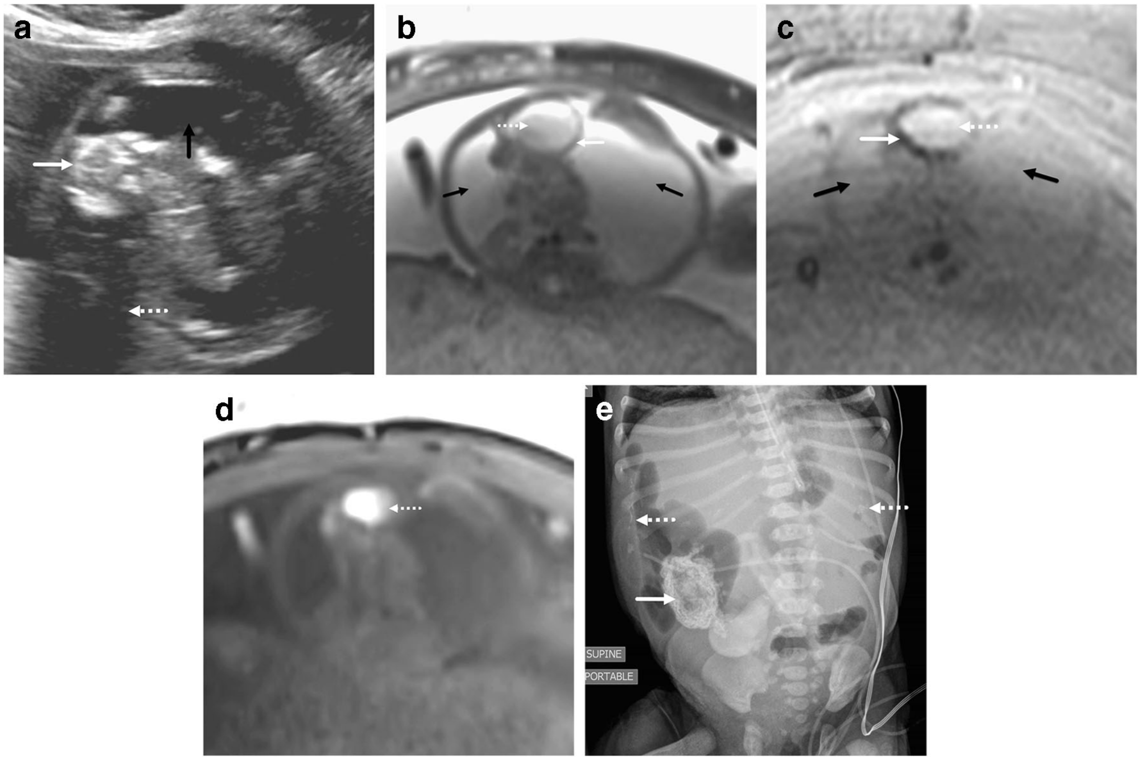


Fig. 12 Bowel perforation and meconium pseudocyst in a 25-week gestation female fetus. **a** Axial US image through the fetal abdomen demonstrates echogenic (*solid white arrow*) and shadowing (*dotted white arrow*) material within the abdomen. Also note the presence of ascites (*black arrow*). **b** Axial half-Fourier acquisition single-shot fast spin echo (HASTE) MR image demonstrates an intraabdominal cyst (*dotted white arrow*) with peripheral low signal intensity (*solid white arrow*), suggestive of calcifications. Also note the presence of ascites (*black arrows*). **c** Axial gradient echo (GRE) MR image confirms the presence of peripheral calcium as demonstrated by signal drop-out (*solid white arrow*) around the cyst (*dotted white arrow*). Also note the presence of ascites (*black arrows*). **d** Axial T1-W volumetric interpolated breath-hold examination (VIBE) MR image shows hyperintense contents within the cyst (*arrow*), compatible with meconium. **e** An anteroposterior abdominal radiograph obtained at Day 1 of age demonstrates calcifications within the meconium pseudocyst (*solid arrow*), in addition to calcifications (*dotted arrows*) lining the peritoneum secondary to perforation and meconium peritonitis

bowel loops. For example, the presence of a swirling pattern of dilated bowel loops should raise concern for a volvulus, which could be the primary cause for bowel obstruction or secondary to a preexisting bowel obstruction. Coronal imaging planes in particular are helpful to assess for this swirling pattern of bowel loops (Fig. 13). Detailed evaluation of the bowel wall is important in these cases because abnormally thickened or thinned walls suggest vascular compromise.

Children with small-bowel or colonic gastrointestinal tract obstruction diagnosed in utero typically have a high survival rate [8, 17]. Lau et al. [17], however, showed that despite a 100% survival rate for small-bowel or colonic obstruction, those with anorectal malformations had a survival rate of only 5.5%. In addition, Rubio et al. [8], in a review of 12 cases of prenatally diagnosed bowel obstruction, described 1 death of a fetus with anal atresia. This higher morbidity in fetuses with anorectal malformations is likely a result of the additional associated anomalies in these patients rather than the anorectal malformation itself.

Children with gastrointestinal tract obstruction have up to 75% incidence of prematurity, which might contribute to increased morbidity and should be discussed in parent counseling [8]. The outcomes of surgical repair of the gastrointestinal tract obstruction should also be considered in counseling. The risk for short gut is the highest in those with multiple atresias, which can be very difficult to identify on both fetal US imaging and MRI [8] (Fig. 14). Interestingly, bowel perforation detected in utero was not found to be specific to development of short gut [8].

Conclusion

Magnetic resonance imaging of the fetal gastrointestinal tract has great utility given the distinct imaging properties of meconium, which allow it to serve the diagnostic function of a "fetal enema." MR imaging can add specificity to prenatal US imaging, particularly through localization of gastrointestinal tract obstructions such as multiple atresias and anorectal malformations, in which there are relatively high rates of morbidity. Complications of gastrointestinal tract obstructions can also be more easily identified on MRI, including meconium

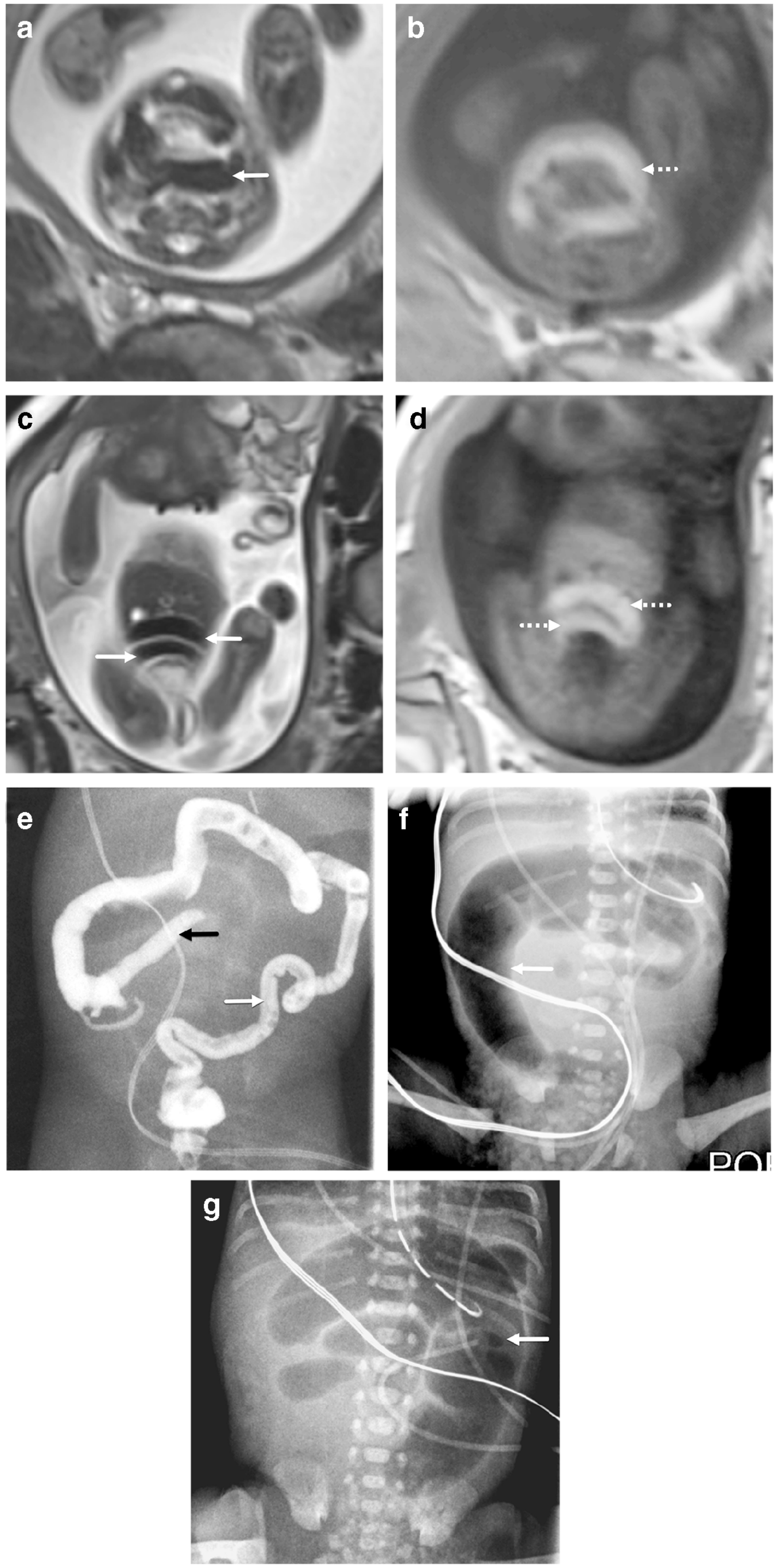


Fig. 13 Type III ileal atresia with internal hernia through the resultant mesenteric defect in a 24-week male fetus. **a**, **b** Axial balanced steady-state free precession (bSSFP) (**a**) and T1-W volumetric interpolated breath-hold examination (VIBE) (**b**) MR images demonstrate a dilated loop of bowel in the mid-abdomen with a swirled configuration, T2-hypointense and T1-hyperintense signals (*arrows*). **c**, **d** Coronal half-Fourier acquisition single-shot fast spin echo (HASTE) (**c**) and T1-W VIBE (**d**) MR images demonstrate similar findings. **e** Postnatal fluoroscopic water-soluble enema demonstrates microcolon (*white arrow*) with reflux into the nondilated distal ileum (*black arrow*), compatible with surgical findings of ileal atresia located 5 cm proximal to the ileocecal valve. **f**, **g** Postnatal Day 1 anteroposterior (AP) abdominal radiograph (**f**) demonstrates a focal dilated loop of bowel in the central abdomen (*arrows*), which rotates clockwise on the postnatal Day 2 AP abdominal radiograph (**g**), suggesting volvulus of the internal hernia, which was confirmed at surgery

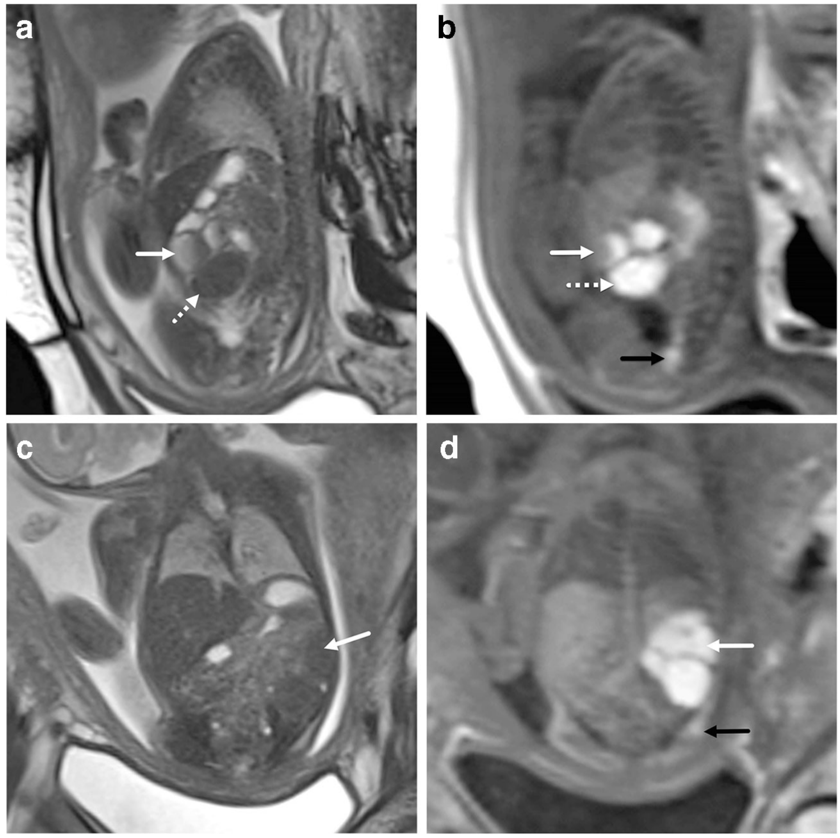


Fig. 14 Multiple short segments of jejunal atresia in a 28-week fetus. **a** Sagittal balanced steady-state free precession (bSSFP) MR image demonstrates dilated proximal small bowel (*solid arrow*) with layering T2-hypointense signal suggestive of stasis. A more distal loop of bowel is T2-hyperintense (*dotted arrow*), suggesting this to be a distal small-bowel loop or colon. **b** Sagittal T1-W volumetric interpolated breath-hold examination (VIBE) image shows accumulation of T1-hyperintense meconium in the dilated segments (*solid white arrow*). The more distal dilated loop of small bowel is meconium-filled (*dotted white arrow*). Also note the presence of a microcolon (*black arrow*). **c**, **d** The corresponding coronal bSSFP (**c**) and T1-W VIBE (**d**) images show similar findings

peritonitis and volvulus, with subsequent implications for delivery and surgical planning. Ultimately, the information provided by prenatal MRI regarding gastrointestinal tract obstructions can help guide prenatal family counseling and direct postnatal care.

Compliance with ethical standards

Conflicts of interest None

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