CASE REPORT

Antenatal diagnosis of intestinal malrotation on fetal MRI

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Received: 2 January 2009 / Revised: 16 February 2009 / Accepted: 2 March 2009 / Published online: 31 March 2009
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Abstract We report a case of intestinal malrotation without any associated GI tract complications diagnosed antenatally by fetal MRI. Antenatal US revealed a midline stomach. Subsequent fetal MRI confirmed the midline stomach and, in addition, revealed all loops of small bowel to the right of the midline and all large bowel to the left. All these features were consistent with intestinal malrotation. There was no abnormal bowel wall thickening, bowel dilatation, ascites or polyhydramnios. To our knowledge, this is a unique case of intestinal malrotation without associated GI tract complications diagnosed antenatally on fetal MRI.

Keywords Antenatal · Malrotation · Fetal MRI

Introduction

Intestinal malrotation occurs when the normal rotational process and fixation of the intestine fails to take place [1]. Absent or abnormal fixation predisposes the bowel to twisting, with consequent vascular disruption and hypoxic-ischemic damage. With its predisposition to volvulus [1], malrotation is a serious condition and therefore antenatal diagnosis would alert the physician to the necessity for close clinical follow-up of the neonate and timely treatment.

Case report

A 35-year-old, gravida 4, para 3 mother was referred to our institution for consultation with an outside US scan performed at 23 weeks' gestation suggestive of a complex congenital heart disease and a lemon-shaped skull. The follow-up US scan and echocardiography at 31 weeks' gestation at our institution revealed complete AV canal defect with right ventricular dominance combined with a hypoplastic aortic valve. There were no features to suggest heterotaxy; however, a midline stomach was observed (Fig. 1). The differential diagnoses for the midline stomach included possible mass in the abdomen displacing the stomach, malrotation and microgastria. An amniocentesis performed at the time of US examination revealed a normal female (46XX) karyotype. Subsequent MR scan, performed at 35 weeks to assess the fetal abdomen and brain, confirmed the midline stomach exhibiting normal high T2 signal (Fig. 2). The small-bowel loops, demonstrating high T2 and intermediate to low T1 signal, were seen situated to the right of the midline (Fig. 2). The large-bowel loops, demonstrating high T1 and low T2 signal, were seen to the left of the midline (Fig. 2). All of these features were...
consistent with malrotation. The heart was not evaluated by MRI and the rest of the visualized anatomy was normal on the MR scan. In view of a previous low transverse caesarean section, the baby was delivered by scheduled caesarean section at 39-3/7 weeks. Over the next few days, the neonate developed respiratory failure, due to which further postnatal assessment and intervention pertaining to the intestinal malrotation could not be addressed. The neonate died on the 12th day secondary to alveolar capillary dysplasia and the complex congenital heart disease.

An autopsy limited to the chest and abdomen confirmed the major clinical diagnoses. Alveolar capillary dysplasia with arterial hypertensive changes was apparent. An unbalanced atroventricular canal consisted of complete absence of the septum primum and upper interventricular system, dysplastic fused tricuspid and mitral valves, and hypoplastic left atrium, ventricle and aorta. As seen on the MR images, the stomach was in the midline. The duodenum was right-sided and the ligament of Treitz was in the midline. The small intestine was located completely on the right side of the abdomen, with completely unfixed

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**Fig. 1** Fetal abdominal US image at 31 weeks’ gestation shows the midline-positioned stomach (straight arrow) in relation to the spine (curved arrow).

**Fig. 2** Fetal MRI at 35 weeks’ gestation. a Fat-saturated axial oblique T2-W image through the fetal abdomen shows the fluid-filled small-bowel loops in the right half of the abdomen (double arrows) and the stomach in the midline (single arrow). Note that the large bowel (arrowhead) is on the left side of the abdomen and exhibits low T2 signal. b Fat-saturated coronal T2-W image through the fetal abdomen shows the fluid-filled small-bowel loops in the right half of the abdomen (double arrows) and the stomach in the midline (single arrow). Note that the large bowel (arrowhead) is on the left side of the abdomen and exhibits low T2 signal. c Fat-saturated coronal T1-W image shows the entire colon (arrowhead) exhibiting normal high T1 signal situated in the left half of the abdomen. The small-bowel loops exhibiting intermediate to low T1 signal are seen in the right half of the abdomen (double arrows).

**Fig. 3** In situ view of abdominal contents, showing the cecum in the left upper quadrant (curved arrow), the entire colon in the left side (arrowhead) and the small intestine (double arrows) in the right half of the abdomen.
mesentery. The cecum and appendix were in the left upper quadrant and the colon was entirely left-sided (Fig. 3). Despite the presence of multiple anomalies, no syndromic diagnosis was forthcoming.

Discussion

Malrotation includes a wide spectrum of anomalies that occur when intestinal rotation and fixation occur in an abnormal fashion. Malrotation has been observed in approximately 1 in 500 live births [1]. When there is early failure of rotation, the small bowel is found on the right side of the abdominal cavity, and the large bowel on the left, as was observed in this case [2].

Malrotation associated with midgut volvulus has been diagnosed antenatally and can be suggested by the presence of abnormally dilated bowel loops [3]. Midgut malrotation associated with cloacal malformation has been diagnosed antenatally on fetal MRI [4]. However antenatal diagnosis of intestinal malrotation without any associated GI tract complications has not been reported previously.

Normal fetal bowel demonstrates characteristic features on MR imaging. After 24 weeks of gestation, the rectum and colon generally demonstrate high T1 and low T2 signal because they contain meconium [4]. The left colon is frequently identified after 24 weeks, whereas the transverse and right colon are identified in 50% of fetuses before 31 weeks [4]. After 33 weeks, the jejunum exhibits high T2 and low T1 signal, as it contains ingested amniotic fluid [4]. The signal in the distal small-bowel loop varies with gestational age and the progression of meconium. These specific signal intensities are useful in identifying the location of the different portions of the bowel, which can help in detecting malrotation.

Malrotation can occur as an isolated condition or in association with other anomalies. Patients with gastroschisis, omphalocele, or diaphragmatic hernia have malrotation and abnormal or absent fixation of the bowel [5, 6]. Malrotation has also been reported following antenatal diagnosis of transient intraabdominal cystic masses [7]. It may also be associated with intestinal atresia, heterotaxy, Hirschsprung disease, and Down syndrome.

MRI will also help to identify other associated gastro-intestinal anomalies including cloacal malformation, intestinal atresia, and other cystic lesions that can be associated with malrotation [4]. Megacystis-microcolon-intestinal hypoperistalsis syndrome can also be associated with malrotation. Fetal MRI can detect the GI findings of extreme microcolon, abnormal rectal signal and midgut malrotation associated with this condition, which cannot be adequately demonstrated on US [4].

We report a case of intestinal malrotation without associated GI tract complications diagnosed antenatally by fetal MRI. The midline position of the stomach was the only clue for possible malrotation on the antenatal US scan. This feature has been observed previously in patients with intestinal malrotation [8].

Antenatal diagnosis of intestinal malrotation did not alter the postnatal management in our case. However, in neonates with no other associated complications, antenatal diagnosis will alert the physicians to the necessity for close clinical follow-up of the neonate and timely treatment.

In conclusion, we believe that fetal MRI, with its ability to identify the different portions of the bowel, can be used complementary to US for detecting intestinal malrotation, especially if sonographic screening demonstrates a malpositioned stomach. It may also help in identifying other GI tract anomalies that can be associated with malrotation.

References