Prenatal Sonographic Diagnosis and Clinical Management of Fetal Small Bowel Volvulus

Dequan Liu  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Xuan Sheng  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Dan Guo  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Houmei Han  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Yang Gao  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Hefeng Wang  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Hong Yin  
Shandong Provincial Maternal and Child Health Care Hospital, Shandong University

Research Article

Keywords: Fetal small bowel volvulus, Prenatal ultrasound, Whirlpool sign, Coffee bean sign, Prenatal diagnosis

Posted Date: October 11th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-786584/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

Background The purpose of this research is to explore prenatal ultrasound features and clinical managements of fetal small bowel volvulus. At present, researchers mainly focus on the prenatal ultrasound features of fetal small bowel volvulus, and rarely summarize them in combination with the principles of clinical treatment.

Methods 11 cases of fetal small bowel volvulus identified by prenatal ultrasound or neonatal surgery in our institution between January 2019 and January 2021 were included. General characteristics of pregnant women, features of prenatal ultrasound, clinical managements and prognosis of neonates were collected. Finally, prenatal ultrasound features and obstetric managements of fetal volvulus was summarized.

Results At the first diagnosis, the whirlpool sign and intestinal dilatation were visualized in 11 cases. 3 cases underwent emergency caesarean because of the disappearance of dilated bowel peristalsis, massive ascites and fetal intrauterine hypoxia. The rest 8 cases were followed up by ultrasound, pregnancy outcomes were four regressed intrauterine spontaneously and delivered at term, two underwent emergency caesarean, one premature and one induced labor. 6 cases underwent neonatal surgery immediately after birth and received favorable outcomes.

Conclusions Intestinal distention and the whirlpool sign are important ultrasonic features in the diagnosis of fetal small bowel volvulus. The disappearance of intestinal peristalsis of the volvulus segment, massive ascites and intrauterine hypoxia are the main basis for emergency prenatal clinical intervention.

Background

Fetal small bowel volvulus is extremely rare which needs aggressive early diagnosis and management to avoid severe morbidity and mortality. Causes of intestinal volvulus includes intestinal malrotation, cystic fibrosis, and mesentery dysplasia, also some fetal intestinal volvulus has no known cause[1–3].

Typical ultrasonic features of fetal intestinal volvulus include intestinal dilatation, whirlpool sign and coffee bean sign[4]. The whirlpool sign is the most reliable way to diagnose intestinal volvulus, which is a mesenteric mass resulting from a spiral involving the mesenteric vessels and the strangulated loops[5, 8]. The coffee bean sign is another reliable sign in the diagnosis of volvulus, it is usually occurs when the inner wall of the dilated bowel is double thickness compared to the outer wall[10, 13].

However, which situation does pregnancy need to be terminated, there is no unified standard. Some studies suggest that the pregnancy should be terminated urgently when prenatal ultrasound indicates the disappearance of intestinal peristalsis, the appearance of ascites and the rapid increase of amniotic fluid[6].
In order to describe and specify ultrasound features of prenatal diagnosis of fetal small bowel volvulus, as well as to provide more clinical reference for subsequent studies, the study analyzed and summarized the sonographic characteristics and obstetrics managements of 11 cases of fetal small bowel volvulus.

**Material And Methods**

The study included 11 cases of fetal small bowel volvulus identified by prenatal ultrasound or neonatal surgery between January 2019 and January 2021 in Maternal and Child Health Care Hospital of Shandong Province, in china. Data were collected through prenatal ultrasound scanning when fetal small bowel volvulus was suspected.

All ultrasound scans were performed with a Ge voluson E10 apparatus equipped with C1-6D convex array probe, selecting the mode of fetal examination in mid and late pregnancy. During prenatal ultrasound examination, pregnant women were all in supine or lateral position if necessary. Firstly, anatomic changes of the twisted intestine such as the degree of intestinal dilatation and inner echo, the echo of intestinal wall and intestinal peristalsis were observed in 2D mode transabdominally. Then compared the blood supply of intestinal wall between normal and twisted intestine by color Doppler or slow flow, and the spatial relationship between of the superior mesenteric artery and vein was indentified at the same time. Sonographic features such as hydrothorax, ascites hydropericardium, peritoneal calcications and pseudocyst were observed. The parameters of fetal umbilical artery, fetal middle cerebral artery (MCA) and ductus venosus(DV) were measured and recorded.

The clinical and general information collected included mothers'age, singleton or multiple pregnancy, circumstances of discovery, gestational age at first diagnosis, any malformation and characteristics of the delivery (pregnancy outcome and pediatric surgery data) and prognosis of infants.

**Results**

General characteristics of the mothers, the pregnancy, and the delivery are presented in Table 1, case by case. The average age of pregnant women was 30.3 ± 3.4 years old (range, 27-39 years old), no obvious past history or family history were found. The average gestational age when first diagnoised on ultrasound was 29.7±4.9 weeks (range, 22+4~35+5 weeks). Small bowel volvulus was diagnosed most often during the third trimester (n = 8) and several on the second trimester (n = 3). There was one fetus from DCDA (dichorionic, diamniotic) and others were singleton. The causes of ultrasound examination included routine antenatal examination, fetal movements reduced, fetal heart rate (FHR) monitoring abnormally, and fetal intestinal dilatation found in other hospitals.

On the basis of full understanding of the fetal situation, a joint counselling was done on suspected fetal volvulus between ultrasound, obstetrician, neonates, paediatric surgeon and the couple. Ultrasound reexamination every 0.5 ~ 2 weeks, emergency cesarean and surgery, induced labor or other treatments were adopted.
1. Ultrasonographic features and prenatal management of fetal intestinal volvulus

Ultrasound features of the 11 cases of small bowel volvulus are presented in Table 2.

At the first diagnosis, the whirlpool sign associated with small bowel dilatation (0.8 ~ 2.5cm) were visualized in all cases, and a moderate to hyperechoic mass could be found in the center of the whirlpool sign. No prenatal ultrasound images showed malrotation.

At the first diagnosis in case 3, 9 and 10, the peristalsis of the dilated bowel was disappeared, no blood signal was found in the intestinal wall under slow flow and fetuses were complicated with massive ascites (Figure 1). There was an echogenic (dense punctate echo or hypoechoic) fluid in dilated small bowel. Besides, case 3 and 10 also presented with gastric dilatation and polyhydramnios, and the FHR of case 9 increased continuously (> 170 bpm) (Figure 2). They have received emergency cesarean because of the frequent late deceleration of FHR. The other cases showed normal peristalsis of dilated small bowel at the first diagnosis, with an anechoic fluid in. Blood signal can be seen in dilated intestinal wall as well as mesenteric vessels gathered in the mass which in the center of the whirlpool sign. As for other abnormal ultrasonic characteristics were invisible (Figure 3). These 8 cases were followed up by ultrasound after multidisciplinary consultation.

However, in our case series, the intestinal dilatation and whirlpool sign was disappeared in case 1 at the seventh week of follow-up, as the same as case 2 and case 11 at the sixth week of follow-up. After 4 weeks follow-up of case 6, the whirlpool sign was disappeared, the diameter of the dilatated loop decreased from 2.1cm to 1.0cm. Finally, the intestinal dilatation was disappeared in 37 weeks of gestation. During the follow-up of the rest 4 fetuses (case 4, 5, 7, 8), things have gone from bad to worse. Case 4 and 7 received emergency cesarean because of intestinal peristalsis disappeared, massive ascites, umbilical artery and MCA abnormalities and intrauterine distress in 33 and 29 weeks of gestation respectively(Figure 4). Case 8 delivered at 36 weeks due to premature rupture of membranes. Case 5 was induced labor because of fetal distress at 26 weeks of gestation.

2. Postpartum outcome

In our series, there were 4 boys and 7 girls. 4 cases (case 1, 2, 6, 11 ) had full term delivery, no abnormality was found of them in the follow-up to 6 months.

6 infants (case 3, 4, 7, 8, 9, 10) performed surgery within 3 days after birth and the small bowel volvulus was demonstrated in operations. Among them, there were 4 cases of anticlockwise torsion, 2 cases of clockwise torsion. Besides, there were 2 cases of 540° torsion, 1 case of 1080° torsion and 3 cases of 720° torsion, the length of the resected necrotic bowel was range from 35 to 55cm. No perforation, atresia, malrotation and other intestinal diseases were found in operations. All infants recovered well without short bowel syndrome.

The mother of case 5 refused autopsy after induced labor.
Discussion

1. General characteristics of fetal small bowel volvulus

Since Crisera et al. first reported fetal midgut volvulus in 1999, more and more cases of intestinal volvulus were confirmed by prenatal diagnosis, but most of them are case reports until now. However, the etiology of fetal small bowel volvulus still unclear. It has been reported that it is associated with malrotation\[2\]. If the relative position of the pedicle of SMA and SMV was used as the criterion for judging malrotation, no signs of malrotation were found in our group. It is suggested that fetal small bowel volvulus is not closely related to malrotation, which is consistent with previous reports\[4,5\]. Studies have reported that fetal intestinal volvulus is closely related to cystic fibrosis\[4\]. However, cystic fibrosis is mainly occured in Caucasian populations, which is rare in Chinese populations.

Fetal intestinal volvulus was mostly diagnosed in the third trimester in previous literatures. In recent years, the intestinal volvulus was gradually detected at an earlier gestational age by prenatal ultrasound. Among 8 cases of fetal intestinal volvulus reported by Sciarrone et al, the earliest diagnosis was made in 20 weeks of gestation\[4\]. In Bartholmot’s study, there were two peaks of diagnosis: the first around 27 weeks of gestation, and the other around 32 weeks\[6\]. In our case series, the earliest diagnosis was made in 22 weeks of gestation, with an average of \((29.7 \pm 4.9)\) weeks of gestation. And 3 cases were found in the second trimester. Besides, about 54.5% \((6/11)\) of pregant women in this situation reported a decrease in fetal movements or abnormal changes of fetal heart monitoring, which is corresponded to some researches\[6,7\]. Therefore, prenatal ultrasound examination should pay more attention to whether fetuses of these pregnant women have signs of small bowel volvulus.

It has been reported that the intestinal volvulus is more frequent in men. Whether there is gender difference in fetal volvulus is unknown, which is rarely mentioned in previous literatures. In 8 cases of fetal volvulus reported by Sciarrone et al, there were 3 female fetuses and 5 male fetuses\[4\]. In our study, we found female fetuses were more prone to intestinal volvulus, the ratio of male to female was 4: 7, which may be related to the small sample.

2. Ultrasonographic features of fetal small bowel volvulus

Fetal small bowel volvulus can show different features on ultrasound according to the degree and the duration of it. The dilatation of small bowel is the most suggestive ultrasound feature in prenatal diagnosis of intestinal volvulus\[4,6\]. All cases in our study have found intestinal dilatation first on ultrasound. The dilated loop of small bowel is usually located in the proximal segment of the torsion, within a fluid-filled level. With the progress of the disease, there is a horizontal level separating an anechoic part superiorly and an echoic part inferiorly. In Bartholmot’s study, this sign was present in 38.5% of his cases, which was seen as a sign of intestinal distress and evidence of a loop without
peristalsis\cite{6}. The echogenic material below probably corresponds to meconium, with more or less blood content.

The whirlpool sign is the most direct prenatal ultrasound sign of diagnosis of intestinal volvulus\cite{4,8-10}, which resulting from a spiral involving the mesenteric vessels and the small bowel around the mesenteric artery or its branches. In our group of cases, the visualization of the whirlpool sign in ultrasound thus defines a positive diagnosis of intestinal volvulus. In addition, the moderate to hyperechoic mass in the center of whirlpool sign is the aggregation of multiple intestinal walls at the origination of torsion. During the follow-up, the mass of one case was no longer visible, accompanied by the disappearance of dilated bowel peristalsis and blood signal. It was considered that the necrosis of the intestinal wall at the torsion leads to the decrease of the mass echo. Another important sign of small bowel volvulus is the coffee bean sign\cite{8,11}. If the volvulus lasts for a long time with a severe degree, the volvulus segment of the intestine may have ischemic necrosis, leading to a local intestinal adhesion. We did not observe this sign in our series, which may be related to the early prenatal treatment in most cases at the first time of diagnosis.

Fetal small bowel volvulus can also accompany with gastric dilatation, ascites, polyhydramnios, abdominal pseudocyst, peritoneal calcification etc. Fukushima et al has reported a case of fetal volvulus with only gastric dilatation at 30 weeks of gestation\cite{12}. In our group, there were 5 cases showed gastric dilatation and four showed polyhydramnios in the first diagnosis or follow-up. It was considered that the gastrointestinal obstruction was caused by intestinal volvulus. Some researchers regard intestinal dilatation, ascites, pseudocyst and peritoneal calcifications as signs of meconium peritonitis\cite{13,14}. However, no signs of peritoneal calcifications were found in 9 cases. Among 6 cases with ascites in our group, there were 4 cases had no evidence of perforation and meconium peritonitis during neonatal operation. Therefore, the ascites is more likely due to the continuous aggravation of torsion, leading to fluid leakage caused by the increase of the internal pressure. At the same time, persistent massive ascites is related to fetal anemia and cardiopulmonary compression leading to fetal ischemic distress\cite{15}.

In our group, 4 cases of intestinal volvulus regressed intrauterine spontaneously within 6 to 7 weeks after the first diagnosis, and the disappearance of whirlpool sign was earlier than intestinal dilatation in one case. In Bartholmot's study, 3 cases of intestinal volvulus showed the complete disappearance of the whirlpool sign in the follow-up ultrasound performed 2 weeks after the diagnosis\cite{6}. However, due to the lack of other prenatal data, the possibility of a false-positive ultrasound diagnosis cannot be completely ruled out.

3. Prenatal treatment and prognosis of fetal small bowel volvulus

The prognosis of fetal small bowel volvulus depends on many factors, including gestational age at diagnosis, degree of volvulus, length of necrotic bowel, severity of complications and birth weight. The prognosis is generally well if effective measures can be taken in time.
In the past, fetal intestinal volvulus was often observed in the third trimester accompanied by perforation, meconium peritonitis or other serious complications, which need an emergency delivery and neonatal operation after diagnosis. But in recent years, the number of fetal intestinal volvulus found in the second trimester has increased gradually. We should balance the risk of volvulus against the survival possibility of premature infants before intervening. And we think the ultrasonic features of intestine volvulus are of great value for prenatal intervention. In Sciarone's study, except for 2 cases received immediate delivery due to ascites and the disappearance of intestinal peristalsis, the rest were followed up by ultrasound every 0.5-3 weeks, and all the fetuses had favorable prognosis finally. 13 cases reported by Bartholmot et al were followed up by ultrasound until delivering except 2 cases induced labor due to cystic fibrosis.

In our study, for those gestational age greater than 32 weeks, considering the higher survival rate of newborns after delivery, once the signs of deterioration of intestinal volvulus were found, such as the disappearance of peristalsis and blood signal of dilated loop, massive ascites, abnormal parameters of blood flow, abnormal FHR monitoring and so on, termination of pregnancy may be more conducive to fetal prognosis. If the gestational age is early than 30 weeks, in order to extend the intrauterine time as far as possible, combining with the wishes of the mother, doctors can monitor the fetuses by ultrasound every 0.5-1 week, so as to reduce the survival risk of premature delivery.

Conclusions

The ultrasonic characteristics of fetal small bowel volvulus are of great value in the formulation of prenatal intervention:

(1). The dilatation of small bowel is the most suggestive ultrasound feature in prenatal diagnosis of intestinal volvulus.

(2). The whirlpool sign is the most direct prenatal ultrasound sign of diagnosis of intestinal volvulus.

(3). For those gestational age greater than 32 weeks, the pregnancy can be ended in time if the fetal small bowel volvulus is aggravated.

(4). For those gestational age early than 30 weeks, if the fetal small bowel volvulus is aggravated, combining with the wishes of the mother, doctors can monitor the fetus by ultrasound every 0.5-1 week to extend the intrauterine time as far as possible.

Prenatally diagnosed fetal small bowel volvulus remains a rare entity, seldom described in the literature. Therefore, ultrasound features of it should be fully understood to improve the diagnostic accuracy. In order to give a guide for prenatal intervention and to improve the prognosis of the fetus, once the diagnosis of prenatal ultrasound is done, multidisciplinary consultation should be organized in time to judge the situation of the suspect fetus according to ultrasound features.
Abbreviations

MCA: Fetal middle cerebral artery; DV: Ductus venosus; DCDA: Dichorionic diamniotic; FHR: Fetal heart rate; SMA: Superior mesenteric artery; SMV: Superior mesenteric vein

Declarations

Ethics approval and consent to participate

Written informed consent was obtained from the pregnant woman, and this study received approval by the Ethics Committee of the Shandong Provinical Maternal and Child Health Care Hospital. Besides, all methods in our study were performed in accordance with the relevant guidelines and regulations (Declaration of Helsinki).

Consent to publication

All participants gave informed consent for their personal or clinical details along with ultrasonic images to be published in this study.

Availability of data and materials

The data analysed during this study are included in the tables in this published article. The datasets used during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

No funding was received for this study.

Authors' contributions

HY proposed the study design. DQL and XS was responsible for writing the manuscript. DG, HMH and YG collected the patient data. The surgery was performed by HFW. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References


Tables

Due to technical limitations, table 1-2 is only available as a download in the Supplemental Files section.

Figures

Figure 1
Case # 3, 33 weeks of gestation. A (axial section): whirlpool sign associated with intestinal dilatation; B (oblique coronary section): The wall of dilated bowel loops was thick. The fluid-filled level was seen clearly in dilated small bowel loops (yellow arrow), and effusion can seen between the intestines (white arrow); C: Blood in the wall of dilated bowel loops was disappear under slow flow mode; D: Gastric dilatation; E: Surgical confirmation of the volvulus with an atresia (dilatation of the proximal gut), and the small intestine twisted clockwise 720°.

Figure 2

Case # 9, 35 weeks of gestation. A: There was an echogenic fluid in dilated small bowel; B: Blood signal of the mass which in the center of whirlpool sign was sparse; C: Surgical confirmation of distal gut was twisted 1080°, and the resection of the necrotic bowel was about 55cm.
Case #1, 24 weeks of gestation. A: whirlpool sign associated with intestinal dilatation (dotted line); B: whirlpool sign in 2D and color Doppler. With color Doppler, blood signal of the mass which in the center of whirlpool sign was visible.

Figure 3
Figure 4

Case # 4. A: 30 weeks of gestation. Whirlpool sign associated with intestinal dilatation; B: 33 weeks of gestation. Intestines of the fetus expanded significantly, with a turbid fluid in. Under slow flow mode, blood signal of the intestinal wall was significantly reduced even disappeared; C: 33 weeks of gestation. PI MCA/ PI UA and PI MCA was reduced; D: Surgical confirmation of the volvulus was anticlockwise twisted 540°, with part of the bowel necrosis.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.xls
- Table2.xls