

HDLive Flow with HDlive Silhouette Mode for Diagnosis of Fetal Diaphragmatic Eventration

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ABSTRACT

We present our initial experience of using HDlive Flow with the HDlive silhouette mode for diagnosing fetal diaphragmatic eventration in one of a pair of monozygotic diamniotic twin fetuses at 21 weeks and 4 days of gestation. Two-dimensional (2D) sonography suggested abnormal elevation of the right hemidiaphragm. Power Doppler ultrasound revealed upward-deviated right pulmonary and hepatic vessels, which were demarcated by the right hemidiaphragm. HDlive Flow with the HDlive silhouette mode clearly depicted the upward-deviated right pulmonary and hepatic vessels, which were separated by the high position of the right hemidiaphragm. The spatial relationships among the fetal liver, diaphragm, lung, and heart could be clearly recognized using HDlive Flow with the HDlive silhouette mode. MRI also strongly suggested right diaphragmatic eventration at 30 weeks and 4 days of gestation. HDlive Flow with the HDlive silhouette mode might be beneficial as an additional diagnostic tool along with conventional 2D sonography, and it facilitates early differentiation between fetal diaphragmatic eventration and diaphragmatic hernia.

Keywords: Diaphragmatic eventration, Fetus, HDlive flow, HDlive silhouette mode, Twin pregnancy

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INTRODUCTION

There have been several studies on conventional three-dimensional (3D) Doppler ultrasound diagnosis of

fetal intra-abdominal vascular anomalies.¹⁻³ However, the image quality was unfavorable, and the spatial relationships among fetal intra-abdominal vessels were unclear.

There have been some reports on the antenatal sonographic diagnosis of fetal diaphragmatic eventration.⁴⁻⁸ However, those sonographic image qualities for diagnosing diaphragmatic eventration were poor. Moreover, the differentiation between congenital diaphragmatic eventration and hernia was very difficult using conventional prenatal sonography.⁹

Recently, 2D sonography with the latest high-resolution probe revealed very clear internal structures of an extremely thickened heterogeneous (jellylike) placenta with severe fetal growth restriction.¹⁰ In the present case, we used the latest 2D sonography to differentiate between fetal diaphragmatic hernia and eventration.

The use of HDlive Flow in conjunction with the HDlive silhouette mode facilitates the spatial visualization of blood vessels in both normal and abnormal fetal cardiovascular systems and in the presence of gynecologic disorders, combining the advantages of being able to spatially view these vessels and visualize landmarks of adjacent structures.¹¹⁻¹⁹ In this report, we present our initial experience of using HDlive Flow with the HDlive silhouette mode for diagnosing fetal diaphragmatic eventration during pregnancy.

CASE REPORT

A 27-year-old pregnant Japanese woman, gravida 1, para 0, was referred to our ultrasound clinic at 21 weeks and 4 days of gestation because of a suspected right diaphragmatic hernia in one of a pair of monozygotic diamniotic twin fetuses. Two-dimensional sonography (Aplio i800, Toshiba Medical Systems, Tokyo, Japan) with the latest high-resolution probe (PVI-475BX, 1.5-6 MHz) suggested an abnormal elevation of the right hemidiaphragm (Fig. 1A). Power Doppler ultrasound revealed upward-deviated right pulmonary and hepatic vessels, which were demarcated by the right hemidiaphragm (Fig. 1B). HDlive Flow with the HDlive silhouette mode (Voluson E10, GE Healthcare Japan, Tokyo, Japan) clearly depicted the upward-deviated right pulmonary and hepatic vessels, which were separated by the high position of

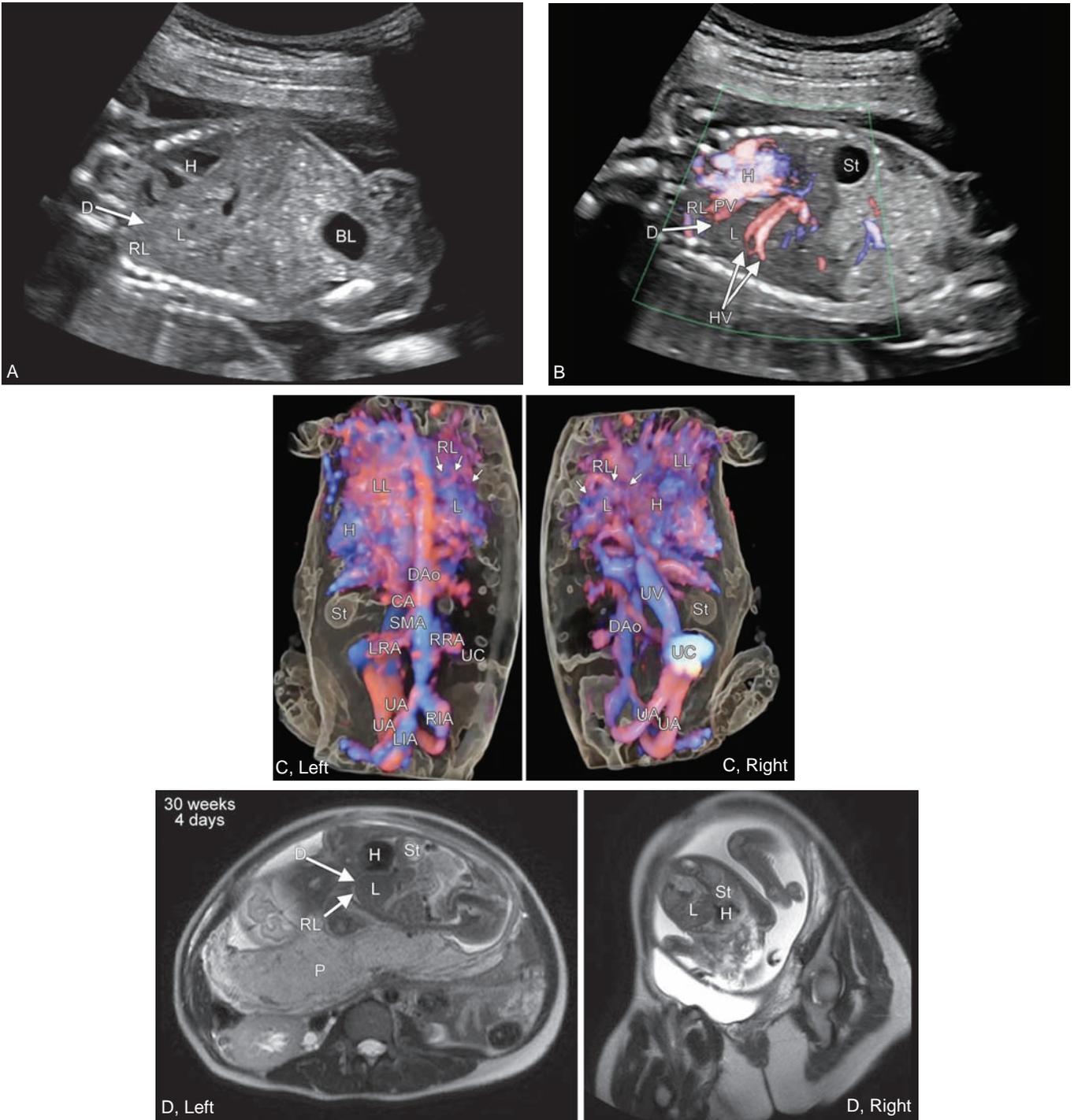
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Figs 1A to D: Two-dimensional sonographic (A) Power Doppler ultrasound (B) HDlive Flow with HDlive silhouette mode (C) images of fetal diaphragmatic eventration at 21 weeks and 4 days of gestation. *a:* An abnormal elevation of the right hemidiaphragm (D) can be noted. *b:* Power Doppler ultrasound reveals upward-deviated right pulmonary (PV) and hepatic (HV) vessels, demarcated by the right hemidiaphragm (D). *C:* This technique clearly shows upward-deviated right pulmonary vessels (RL) and the hepatic vessels (L) extending above the level of the left diaphragm (arrows) in the herniated liver (L), separated by the high position of the right hemidiaphragm (D). Moreover, the spatial relationships among the fetal liver (L), diaphragm (arrows), right (RL) and left (LL) lungs, heart (H), stomach (St), and spine (Sp) can be clearly recognized. *Left*, posterior view; *Right*, anterior view. (D): MRI T2-weighted image of fetal diaphragmatic eventration in one (*Left*) of a pair of monozygotic diamniotic twin fetuses, clearly showing abnormal elevation of right hemidiaphragm (D) at 30 weeks and 4 days of gestation. The level of the diaphragm of the healthy co-twin fetus is normal (*Right*). (Abbreviations : BL, bladder; CA, celiac artery; DAo, descending aorta; H, heart; L, liver; LIA, left iliac artery; LRA, left renal artery; P, placenta; RIA, right iliac artery; RL, right lung; RRA, right renal artery; SMA, superior mesenteric artery; St, stomach; UA, umbilical artery; UC, umbilical cord; UV, umbilical vein)

the right hemidiaphragm (Fig. 1C and Videoclip S1). The spatial relationships among the fetal liver, diaphragm, lung, heart, stomach, and spine could be clearly

recognized using HDlive Flow with the HDlive silhouette mode. MRI also strongly suggested right diaphragmatic eventration at 30 weeks and 4 days of gestation (Fig. 1D).

At 36 weeks and 4 days, the elective cesarean section was performed because of increasing uterine contractions, resulting in a twin female newborn weighing 1,984 g, and affected co-twin female newborn weighing 2,520 g. The Apgar score of the healthy twin neonate was 2 at 1 minute and 3 at 5 minutes, with an umbilical artery pH of 7.207. The Apgar score of the affected twin neonate was 2 at 1 min and 5 at 5 min, with an umbilical artery pH of 7.208.

An emergency operation was performed due to suspected diaphragmatic hernia because of difficult respiratory care of the neonate on Day 3. Right diaphragmatic eventration was confirmed during the operation, and diaphragmatic plication was conducted. The baby followed a favorable course after the operation.

DISCUSSION

Conventional 2D sonographic differentiation between fetal diaphragmatic eventration and hernia was previously very difficult because of poor resolution of the image quality and thinning of the affected diaphragm.^{4,5,9} Color Doppler ultrasound showed the abnormal position of intrahepatic vessels in a patient with a thoracic herniated liver and congenital diaphragmatic defects.²⁰ In the present report, the high-resolution probe clearly identified the high position of the right hemidiaphragm, and power Doppler ultrasound demonstrated upward-deviated right pulmonary and hepatic vessels, which were demarcated by the right hemidiaphragm. This technique may be able to detect the subtle changes of echogenicity in different fetal organs.

HDlive Flow in conjunction with the HDlive silhouette mode could successfully generate spatial 3D images of the high vascular pattern of the fetus with hepatic hemangioma, clearly showing tightly packed blood vessels and blood flow in multiple directions. Spatial relationships were also identified between the tumor and adjacent anatomical landmarks: spine, diaphragm, descending aorta, inferior vena cava, and umbilical vein.¹⁴ In the present case, this technique clearly depicted upward-deviated right pulmonary vessels and the hepatic vessels extending above the level of the left diaphragm in the herniated liver, which was separated by the high position of the right hemidiaphragm. Moreover, the spatial relationships among the fetal liver, diaphragm, lung, heart, stomach, and spine could be recognized. HDlive Flow with the HDlive silhouette mode allows the spatial visualization of fetal blood vessels in intra-thoracic and intra-abdominal cavities and may have the merit of being able to provide a spatial view of normal and abnormal fetal vessels as well as the visualization of landmarks of

adjacent fetal structures. This technique may provide useful information on the diagnosis of normal and abnormal fetal vessels. Further studies involving a larger sample size are needed to confirm the usefulness of this technique to diagnose abnormal fetal vascular structures.

ETHICAL CONSIDERATIONS

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study.

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NOTE : Videoclip S1: HDliveFlow with HDlive silhouette mode videoclip of fetal diaphragmatic eventration, clearly showing the spatial relationship with the surrounding organs and fetal vessels at 21 weeks and 4 days of gestation. (available online only).

