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What Is the Clinical Importance of Echogenic Material in the Fetal Frontal Horns?

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Abstract

Objective—The purpose of this study was to evaluate the importance of echogenic material in the fetal frontal horns.

Methods—This was a Health Insurance Portability and Accountability Act–compliant, Institutional Review Board–approved retrospective study. In part 1 of the study, prenatal sonography, prenatal magnetic resonance imaging (MRI), and birth outcomes of 17 fetuses (mean gestational age, 19 weeks; range, 15–34 weeks) with prospective echogenic material in the frontal horns were assessed. In part 2, 400 consecutive sonographic fetal surveys (mean gestational age, 19 weeks; range, 15–38 weeks) were reviewed to determine the incidence. In part 3, 2 independent reviewers assessed the appearance of the frontal horns in 40 fetuses (20 with suspected intraventricular hemorrhage from parts 1 and 2 and 20 who were interpreted to have normal findings in part 2).

Results—Part 1 of the study showed that suspected hemorrhage was unilateral in 13 fetuses and bilateral in 4. Additional findings by sonography were grade 4 intraventricular hemorrhage ($n = 2$), ventriculomegaly ($n = 2$), and porencephaly ($n = 1$). An additional finding by MRI was porencephaly in 1 fetus. In part 2, echogenic material in the frontal horns was identified in 3 of 400 fetuses (0.8%). In part 3, hemorrhage was probably or definitely present in 11 of the 20 fetuses with abnormalities; material looked like a cyst in 6; and normal choroid was in an abnormal position in 2 and a normal position 1. Of 19 fetuses with abnormalities, 14 had a posteriorly symmetric choroid; 9 had material of different echogenicity compared with the choroid; and 17 had an expanded frontal horn. Birth outcomes were abnormal in 7, including platelet abnormalities ($n = 2$), hemorrhage on imaging or pathologic examination ($n = 2$), extraventricular hemorrhage ($n = 3$), and ventriculomegaly ($n = 3$).

Conclusions—The incidence of echogenic material in the frontal horns is less than 1%. This does not represent the normal location of the choroid plexus and may represent hemorrhage, which may resolve without sequelae or result in ventriculomegaly and porencephaly.

Keywords

central nervous system; fetal frontal horns; intraventricular hemorrhage

The normal sonographic appearance of the choroid plexus in neonates is that of echogenic material extending from the tip of the temporal horn, behind and over the thalamus, and along the floor of the lateral ventricle to the level of the foramen of Monro.¹ Because the normal choroid plexus is not seen anterior to the foramen of Monro in healthy neonates, echogenic material seen in this region is thought to represent hemorrhage originating in the germinal matrix.¹ However, the importance of this sonographic finding in the fetus has not, to our

knowledge, been described. Although in the neonate it is thought to represent hemorrhage, it is not clear in the fetus whether the choroid plexus can normally extend anteriorly. Therefore, we performed this study to evaluate the clinical importance of echogenic material in the fetal frontal horns.

Materials and Methods

This Health Insurance Portability and Accountability Act-compliant, Institutional Review Board-approved retrospective study was performed in 3 parts. Part 1 assessed studies that were prospectively interpreted as having echogenic material in the fetal frontal horns. This material was more echogenic than cerebrospinal fluid (CSF) in the ventricle but could be less echogenic than the choroid plexus. Part 2 was performed to assess the incidence of this finding in our fetal population. Part 3 was performed to assess whether the echogenic material was subjectively due to an abnormal position of the choroid versus hemorrhage. Figure 1 is a flow diagram of the study.

Part 1

We retrospectively reviewed 2-dimensional sonography and magnetic resonance imaging (MRI) of 17 consecutive fetuses evaluated in our department between August 2003 and April 2007 with prospective interpretation of echogenic material in the frontal horns of the lateral cerebral ventricles. Referral indications, the gestational age by sonography, the gestational age by the last menstrual period (LMP), and imaging findings on sonography and MRI were recorded. Follow-up sonography and MRI as well as postnatal clinical data and pathologic findings were reviewed. When porencephaly was present, this was considered grade 4 hemorrhage.

Part 2

A power analysis was performed to assess how many studies would need to be reviewed to determine whether echogenic material in the frontal horns was a finding seen in less than 1% of the population (our assumption based on this being a presumed rare finding). To show a difference of 1% to 2%, 400 cases would be needed. Therefore, 400 cases were reviewed.

A radiologist with 14 years of experience in obstetric imaging retrospectively reviewed 400 consecutive fetal surveys performed between 15 and 38 weeks' gestation with attention to the view of the cavum septum pellucidum in either the axial or coronal plane to ensure visualization of the frontal horns. Fetuses with known central nervous system malformations or referral for echogenic material in the frontal horns were excluded. The gestational ages by sonography and LMP were recorded, as was the indication for the examination. Examinations were stratified into low-risk indications and high-risk indications (such as advanced maternal age, multiples, abnormal first-trimester screening results, maternal disease, and known fetal anomalies). Fetal surveys showing echogenic material in the frontal horn were recorded, and follow-up from these pregnancies was obtained. Incidence rates in high- and low-risk populations were calculated.

Part 3

The 20 fetuses with presumed hemorrhage found in parts 1 ($n = 17$) and 2 ($n = 3$) of the study were age matched with healthy fetuses from part 2. Two independent blinded reviewers (radiologists with 2 and 12 years of experience in obstetric imaging not involved in parts 1 and 2) completed a questionnaire for each of the 40 cases, assessing the following:

1. Was the choroid plexus normal (1, normal; 2, probably normal, including choroid plexus cysts; 3, normal choroid in an abnormal position; 4, probably hemorrhage; and

5, definitely hemorrhage)? For cases scored as 2 to 5 in question 1, the following were answered:

2. Was the choroid plexus in the normal position, as assessed by the most posterior aspect of the choroid (1, completely symmetric, with both posterior aspects of the choroid plexus in the normal position; 2, almost symmetric, probably normal position; 3, could not tell; 4, probably asymmetric, the one with material in the frontal horn probably having moved forward; and 5, completely asymmetric, the choroid with the material in the frontal horn having moved anteriorly)? This was later compressed into 2 responses (yes for scores of 1 and 2 and no for scores of 3–5).
3. Did the material in the frontal horn have different echogenicity compared with the normal choroid (1, material with echogenicity exactly like that of the normal choroid; 2, echogenicity similar to that of the normal choroid but with a separation between the choroid and the material in the frontal horn; 3, could not tell; 4, echogenicity slightly different from that of the normal choroid; and 5, echogenicity definitely different from that of the normal choroid)? This was later compressed into 2 responses (yes for scores of 4 and 5 and no for scores of 1–3).
4. Was the involved frontal horn expanded by the material (1, not expanded; 2, probably not expanded; 3, could not tell; 4, probably expanded; and 5, definitely expanded)? This was later compressed into 2 responses (yes for scores of 4 and 5 and no for scores of 1–3).

Differences of opinion in part 3 were decided by consensus of the 3 reviewers.

Imaging

Fetal surveys were performed in compliance with American Institute of Ultrasound in Medicine guidelines² with Voluson 730 Expert (GE Healthcare, Waukesha, WI), iU22 (Phillips Healthcare, Andover, MA), and HDI 5000 (Phillips Healthcare) equipment. These guidelines include views of the lateral ventricles and cavum septum pellucidum. Magnetic resonance imaging was performed with Signa Excite and Signa Genesis 1.5-T magnets (GE Healthcare). Sequences changed during the duration of the study but in general were single-shot fast spin echo using an echo time of 88 milliseconds and flip angle of 90° with a 4-mm slice thickness in 3 planes through the fetal brain. Three-dimensional T1-weighted gradient echo (liver acquisition with volume acquisition) images of the fetal brain were obtained in 1 or 2 planes using 4-mm slices with a repetition time of 5.5 milliseconds, an echo time of 1.8 milliseconds, and a flip angle of 10°. The field of view was tailored to the maternal body size and size of the fetus. Hemorrhage on MRI was diagnosed when a low signal on T2-weighted imaging or a high signal on T1-weighted imaging was seen in the ventricles.

Statistical Analysis

The gestational ages of the fetuses in parts 1 and 2 were compared by the Mann-Whitney *U* test. Percent agreement between the 2 secondary reviewers was calculated for agreement of the exact response and agreement within 1 category of the response (eg, score of 4, echogenicity slightly different from that of the normal choroid by 1 reviewer; or score of 5, echogenicity definitely different from that of the normal choroid).

Results

Part 1

Seventeen fetuses were prospectively described as having echogenic material in the frontal horns with a mean gestational age of 20 weeks (range, 15–34 weeks; median, 19 weeks) by sonography and 20 weeks (range, 15–36 weeks; median, 18 weeks) by the LMP. There was 1

set of dichorionic twins, with each twin having the sonographic finding of echogenic material in the frontal horn. At presentation, 13 fetuses had unilateral echogenic material in a frontal horn, and 4 had bilateral findings. Additional sonographic findings were grade 4 intraventricular hemorrhage in 2 fetuses, ventriculomegaly in 2, and porencephaly in 1 (Table 1).

Sixteen of 17 fetuses underwent MRI within 0 to 16 days of the index sonograms (Table 1). Of the 16 fetuses who underwent MRI, a low signal was shown on T2-weighted imaging, consistent with blood products in the frontal horns, in 12. One of these fetuses (with MRI performed the same day as sonography) had an additional finding (not seen on sonography) of porencephaly (Figure 2). Four fetuses with echogenic material in the frontal horns on sonography had a normal MRI findings.

Eleven of 17 fetuses (72%) had follow-up sonograms; 8 of 11 (72%) had echogenic material seen on the first follow-up sonogram (1–5 weeks after the index sonogram) with resolution over time (2–16 weeks) in 7 of 11 (63%).

Fourteen of the 17 fetuses referred had isolated echogenic material in the frontal horns seen on the sonograms. One of these pregnancies underwent termination because the patient had a history of a pregnancy affected by idiopathic thrombocytopenic purpura, with a presumed similar diagnosis in this pregnancy. At autopsy, this fetus had a platelet count of 5000 (normal at birth is >150,000) and thus was thought to have idiopathic thrombocytopenic purpura. One fetus was also thought to have bleeding diathesis of unknown etiology. This fetus had borderline low platelets at birth of 150,000 and had a slightly elevated prothrombin time of 17.1 seconds (normal, 10.1–16.9 seconds) and an international normalized ratio of 1.9 (normal, 0.53–1.62).³ One patient terminated the pregnancy, and the fetus had pathologically proven germinal matrix hemorrhage. Ventriculomegaly developed in 1 fetus later in pregnancy. Ten fetuses had normal neonatal outcomes.

Part 2

A total of 400 consecutive fetal surveys with a mean gestational age of 19 weeks (range, 15–38 weeks; median, 18 weeks) by sonography and 19 weeks (range, 12–37 weeks; median, 18 weeks) by the LMP were retrospectively reviewed. These gestational ages were not significantly different from those of the fetuses in part 1 ($P = .10$ for age by sonography; $P = .38$ for age by the LMP); 191 fetuses (48%) were high risk, and 209 (52%) were low risk. Echogenic material was seen in a frontal horn in 3 fetuses (0.8% of the total group 2 population) at 17–19 weeks' gestational age. Follow-up imaging in these 3 fetuses showed a normal choroid plexus and lateral ventricles in 2 fetuses 7 and 9 weeks after the initial scans (gestational age of 26 weeks for both). The third fetus had persistence of echogenic material 4 weeks later (22 weeks by dates) with resolution at 33 weeks. All 3 fetuses with echogenic material were in the low-risk population, and all 3 had normal neonatal physical examination findings (2 were born by cesarean delivery and 1 by vaginal delivery).

Part 3

Of the 20 healthy control fetuses, none were thought to have hemorrhage in the frontal horns by either of the independent reviewers. Of the 20 fetuses with presumed hemorrhage in parts 1 and 2, the reviewers thought that hemorrhage was probably or definitely present in 11 and that the material looked like a cyst in 6 (Figure 3). One fetus was judged to be have no abnormalities by both reviewers (twin pregnancy with 1 twin being judged as having abnormalities by the reviewers and 1 being judged as having no abnormalities). One fetus was judged to have no abnormalities by 1 reviewer, to probably have abnormalities by the second reviewer, and to probably have abnormalities by consensus. Both secondary reviewers scored

the frontal horn appearance as abnormal in 18 fetuses. In categorizing the symmetry of the choroid plexus posteriorly, the reviewers agreed exactly in 14 of 18 (78%) or within 1 category of response in 17 of 18 (83%). These rates were 10 of 18 (56%) and 15 of 18 (83%) for the question regarding the echogenicity of the material. The rates were 3 of 18 (17%) and 15 of 18 (83%) for the question regarding expansion of the frontal horn.

Table 1 summarizes the consensus opinions for the 20 fetuses in parts 1 and 2 who were identified as potentially having echogenic material in the frontal horns. Of these, the consensus opinions were that 5 had a posteriorly asymmetric choroid plexus (Figure 4). Each of these 5 cases had a consensus opinion that hemorrhage was probably or definitely present, only 1 (20%) of whom had a normal outcome. Nine fetuses had material of different echogenicity in the frontal horn compared with the choroid (Figure 5), 5 (55%) of whom had normal outcomes. An expanded frontal horn was seen in 17 fetuses, 11 (64%) of whom had normal outcomes. The appearance of a cyst was seen in 6 fetuses, all (100%) of whom had normal outcomes.

Discussion

The function of the choroid plexus is to produce CSF. As part of the blood-brain barrier, it facilitates removal of brain metabolites through bulk drainage of CSF and has an active role in the development, homeostasis, and repair of the central nervous system.⁴ The choroid plexus originates from ependymal cells located in the medial aspect of the lateral ventricles.⁵ The normal choroid plexus is located in the lateral, third, and fourth ventricles. Sonographically, the choroid plexus has well-defined echogenic material seen in the lateral ventricles extending from the anterior temporal horns to the body of the ventricles. In the sagittal plane, the choroid plexus is seen along the roof of the temporal horn, sweeping posterior and superior to the thalamus along the floor of the lateral ventricle to the foramen of Monro. It passes through the foramina, lining the roof of the third ventricle.¹ The location and size of the choroid plexus vary throughout gestation, reaching a maximum size at 11 weeks, when the choroid fills 75% of the volume of the lateral ventricle from the foramen of Monro to the atrium.⁵ As the fetus matures, the choroid fills a lower volume of the ventricle and appears to be more posterior in location.⁶

In the setting of germinal matrix hemorrhage in the neonate, material similar in echogenicity to that of the choroid plexus extends anterior to the foramen of Monro along the head of the caudate. With intraventricular hemorrhage, a clot will form on the surface of the choroid, causing it to appear enlarged and irregular.^{1,5} Parenchymal hemorrhage is seen as a densely echogenic mass within parenchyma, frequently extending from the subependymal layer of the ventricle.^{5,6} Although this appearance of intraventricular hemorrhage with an enlarged irregular choroid plexus is well accepted in fetuses, to our knowledge, the clinical importance when isolated echogenic material is seen in the fetal frontal horn is not yet known.

Intracranial hemorrhage in the fetus can be due to numerous maternal and fetal causes, including maternal hemorrhage, hypertension, substance abuse, isoimmune thrombocytopenia, fetal hydrops, fetal coagulopathy, and idiopathic hemorrhage.⁷⁻¹¹ However, only 2 of our 17 prospective cases had an identifiable cause. The prognosis of fetuses with intracranial hemorrhage is dependent on the grade.^{12,13} Cases with hemorrhage confined to the germinal matrix (grades 1 and 2) generally have good postnatal outcomes, and those with large intraventricular and parenchymal hemorrhage (grades 3 and 4) have poor postnatal outcomes or death. Sonography and MRI can help stratify these risks and assist with patient counseling.^{14,15}

In our population, sonographically the material was of different echogenicity compared with the choroid plexus in 9 of 20 cases (45%). Associated sonographic findings of parenchymal

abnormalities and porencephaly confirmed the diagnosis in 3 cases. The value of MRI is to confirm the presence of blood products and to evaluate for parenchymal abnormalities that may not have been seen on sonography. In our population, MRI supported the diagnosis with the depiction of blood products in the area of abnormal signal intensity in 12 of 16 cases (75%) and in 1 case showed an additional finding of porencephaly. However, it should be noted that 8 of 20 cases (40%) had no confirmation of the diagnosis by prenatal MRI or associated findings; thus, we cannot be certain that all cases in our series represented hemorrhage.

To assess for other potential nonhemorrhagic causes of the presence of material in the frontal horns, we hypothesized that the choroid on one side could have been positioned in a more anterior location than is typical; thus, we assessed for symmetry of the posterior aspect of the choroid plexus. Five of 19 cases were thought to have asymmetry of the posterior aspect of the choroid. However, each of these 5 cases had a consensus opinion that hemorrhage was probably or definitely present, only 1 of whom had a normal outcome. Therefore, posterior asymmetry of the choroid should alert the sonographer to carefully interrogate the frontal horns. In addition, this is unlikely to be a helpful finding when echogenic material is seen bilaterally because the posterior aspect of the choroid could appear symmetric; thus, the appearance of the posterior aspect of the choroid is unlikely to be a helpful determinant of the etiology of echogenic material in the frontal horns.

Our second hypothesis was that a choroid plexus cyst could have pushed the choroid forward; thus, we assessed for cysts. Interestingly, 6 of the fetuses were judged to have cysts in the choroid or frontal horn material by our secondary reviewers. Each of these fetuses had resolution of the appearance over time and had a normal outcome. However, it should be noted that when hemorrhage evolves, it could give an appearance of a cyst; thus, further study and longer-term outcomes are needed before all of these can be presumed to be nonhemorrhagic causes of the appearance.

Our study had limitations. The frontal horns are not necessarily completely visualized on routine survey images, and small amounts of echogenic material may be missed; therefore, the incidence based on this series could be underestimated. In addition, whereas resolution of the presumed hemorrhage in utero is reassuring, not all fetuses had postnatal or autopsy follow-up. None of the neonates was followed long term. Further prospective investigation with postnatal follow-up imaging may add more information regarding the prognoses of the affected fetuses.

In conclusion, the incidence of echogenic material in the frontal horns of the lateral ventricles is less than 1%. Most fetuses with this appearance as the sole sonographic finding will have normal neonatal outcomes. Although this likely represents intraventricular hemorrhage in otherwise low-risk fetuses, it could also represent an abnormal position of the choroid plexus, in particular if a cyst is visualized. This finding can result in ventriculomegaly and porencephaly; thus, follow-up imaging and assessment for bleeding diathesis are warranted.

Abbreviations

CSF	cerebrospinal fluid
LMP	last menstrual period
MRI	magnetic resonance imaging

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Figure 1.
Flow diagram of study. IVH indicates intraventricular hemorrhage.

Figure 2.

Fetus at 20 weeks' gestational age with echogenic material in the frontal horn on sonography and porencephaly on MRI. **A**, Coronal transabdominal sonogram showing echogenic material in 1 frontal horn with expansion of the horn (arrow). **B**, Coronal T2-weighted MRI showing expansion of the involved frontal horn and a low signal within the ventricle, representing hemorrhage (arrow). There is irregularity of the lateral wall of the ventricle (arrowhead). **C**, Coronal T2-weighted MRI showing high-signal intensity CSF extending outside the normal confines of the ventricle and into the parenchyma, consistent with porencephaly (arrowhead), which was not shown on the sonogram.

Figure 3. Fetus at 21 weeks' gestational age with material in the frontal horns that appears cystic: transabdominal coronal sonogram showing a cyst within the frontal horn with expansion (arrow).

Figure 4. Fetus at 16 weeks' gestational age with an asymmetric appearance of the choroid plexus. **A**, Axial transabdominal sonogram of the fetal head showing asymmetry of the choroid plexus, with the far-field ventricle (arrow) extending further anteriorly than the near-field ventricle. **B**, Coronal transabdominal sonogram showing echogenic material in the far-field frontal horn with expansion (arrow).

Figure 5.

Fetus at 19 weeks' gestational age with material in the frontal horns that is hypoechoic compared with the choroid plexus but echogenic compared with CSF. **A**, Axial transabdominal sonogram of the fetal head showing hypoechoic material (arrow), which is contiguous with the choroid plexus, extending into the frontal horn of the near-field ventricle. The far-field choroid is slightly heterogeneous without extension into the frontal horn. **B**, Coronal T2-weighted MRI of the fetal head showing expansion of 1 frontal horn with subtle low signal intensity within and lining the ventricle (arrow).

Imaging and Clinical Findings

Table 1

GA at sonography (LMP), wk	Sonography	MRI	Follow-up Sonography	Follow-up MRI	Outcome	Hemorrhage Present	Choroid Symmetric Posteriorly	Different Echogenicity	Frontal Horn Expanded
Prospective interpretation of hemorrhage (part 1)									
19 (18)	R hemorrhage	R hemorrhage	ND	ND	I/P, TAB, Pathology: platelets <5000	Probably hemorrhage	Yes	Yes	Yes
16 (15)	L hemorrhage	Normal	Hemorrhage (20 wk), normal (24, 30 wk)	L hemorrhage (20 wk)	Bleeding diathesis, CD (borderline low platelets, elevated PT and INR)	Probably hemorrhage	No	Yes	Yes
20 (18)	R hemorrhage	R hemorrhage	Hemorrhage (21, 27 wk), normal (34 wk)	Hemorrhage (21, 27 wk), normal (34 wk)	Resolution by prenatal imaging	Looked like cyst	Yes	No	Yes
21 (21)	L hemorrhage	L hemorrhage	Hemorrhage (23 wk), normal (27 wk)	Normal (23 wk)	Resolution by prenatal imaging	Looked like cyst	Yes	No	Yes
19 (18)	BL hemorrhage	BL hemorrhage	Hemorrhage (21 wk), normal (34 wk)	Hemorrhage (21 wk) normal (34 wk)	NSVD, normal neonatal findings	Looked like cyst	Yes	Yes	Yes
18 (18)	L hemorrhage	L hemorrhage	Hemorrhage, VM (10 mm) (20, 22 wk)	Hemorrhage VM (10 mm) (20, 22 wks)	VM by prenatal imaging	Definitely hemorrhage	Yes	No	Yes
18 (18) ^a	L hemorrhage	L hemorrhage	Normal (20, 22 wk)	Normal (20, 22 wk)	Resolution by prenatal imaging	Normal	NA	NA	NA
19 (19)	L hemorrhage ^b	L hemorrhage	Hemorrhage (22 wk)	Hemorrhage (22 wk)	TAB, germinal matrix hemorrhage	Probably hemorrhage	Could not tell	Yes	Yes
20 (21)	R hemorrhage, VM (10 mm)	R hemorrhage, VM (10 mm), porencephaly	ND	ND	Grade 4 hemorrhage and VM by prenatal imaging	Abnormal position of choroid	No	No	No
19 (19)	R hemorrhage, CPC	Normal	ND	ND	NSVD, normal neonatal findings	Looked like cyst	Yes	No	Yes
19 (19)	L hemorrhage	Normal	Normal (21, 25, 32 wk)	Normal (21, 25, 32 wk)	NSVD, normal neonatal findings	Probably hemorrhage	Yes	Yes	Yes
20 (20)	L hemorrhage	L hemorrhage	Normal (22, 24, 28, 34 wk)	Normal (22, 24, 28, 34 wk)	NSVD, normal neonatal findings	Probably hemorrhage	Yes	Yes	Yes
22 (22)	R hemorrhage	Normal	Hemorrhage (24, 28 wk)	Normal (28 wk)	CD, normal neonatal findings, normal head sonographic findings at birth	Looked like cyst	Yes	No	Yes
18 (18)	L hemorrhage	L hemorrhage	Hemorrhage (20 wk), asymmetric ventricles (9 and 8 mm, 27 wk)	ND	CD, normal neonatal findings	Looked like cyst	Yes	No	Yes

GA at sonography (LMP), wk	Sonography	MRI	Follow-up Sonography	Follow-up MRI	Outcome	Hemorrhage Present	Choroid Symmetric Posteriorly	Different Echogenicity	Frontal Horn Expanded
29 (29)	BL intraventricular parenchymal and extra-axial hemorrhage, BL VM	BL intraventricular parenchymal and extra-axial hemorrhage, BL VM	ND	ND	Grade 4 hemorrhage and VM by prenatal imaging, TAB, no autopsy	Definitely hemorrhage	Yes	Yes	Yes
34 (36)	BL hemorrhage, porencephaly	BL hemorrhage, porencephaly	ND	ND	Grade 4 hemorrhage by prenatal imaging	Definitely hemorrhage	No	No	Yes
15 (16)	BL hemorrhage	ND	ND	ND	NSVD, normal neonatal findings	Probably hemorrhage	Yes	No	No
Retrospective interpretation of hemorrhage (part 2)									
19 (19)	L hemorrhage	ND	Hemorrhage (21 wk), normal (26, 28, 32, 36, 38 wk)	ND	CD, normal neonatal findings	Abnormal position	Yes	Yes	Yes
17 (18)	R hemorrhage	ND	Hemorrhage (22 wk), normal (33 wk)	ND	NSVD, normal neonatal findings	Probably hemorrhage	No	No	Yes
17 (17)	L hemorrhage	ND	Normal (26 wk)	ND	CD, normal neonatal findings	Probably hemorrhage	Yes	Yes	Yes

BL indicates bilateral; CD, cesarean delivery; CPC, choroid plexus cyst; GA, gestational age; INR, international normalized ratio; ITP, idiopathic thrombocytopenic purpura; L, left; NA, not applicable; ND, not done; NSVD, normal spontaneous vaginal delivery; PT, prothrombin time; R, right; TAB, therapeutic abortion; and VM, ventriculomegaly.

^aTwin of above.

^bOther findings of horseshoe kidney and 2-vessel cord.