Prenatal Sonography in Hydranencephaly
Findings During the Early Stages of Disease

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The purpose of this report is to describe the prenatal sonographic findings in fetuses with hydranencephaly diagnosed during the early stages of disease. Four cases with characteristics of hydranencephaly were retrospectively identified from 2 Latin American fetal medicine referral centers. Information on maternal demographics, sonographic findings, antenatal courses, and pregnancy outcomes was retrieved from the ultrasound reports and medical records. Cases were diagnosed between 21 and 23 weeks’ gestation. The sonographic findings were similar in all cases and included absent cerebral hemispheres, which were replaced by homogeneous echogenic material filling the supratentorial space, and preservation of the thalami, brain stem, and cerebellum. The head circumference measurement was within the normal range, but the transverse cerebellar diameter was below the fifth percentile in 3 of the 4 cases. A follow-up scan in 1 of these cases demonstrated the classic anechoic fluid-filled appearance of hydranencephaly 2 weeks after diagnosis. Confirmation of the diagnosis was available in 2 cases, by postmortem examination in 1 and by fetal magnetic resonance imaging in the other. No further investigations were performed in the 2 women who opted for termination of pregnancy. In conclusion, during the early stages of disease, hydranencephaly is characterized by the presence of a large intracranial saclike structure containing homogeneous echogenic material, representing blood and necrotic debris secondary to massive liquefaction of the developing cerebral hemispheres.

Key Words—cerebral ischemia; fetal sonography; fetus; hydranencephaly; intracranial hemorrhage; prenatal diagnosis

Hydranencephaly is a severe, sporadic brain abnormality characterized by absence of the cerebral hemispheres, which are replaced by a large supratentorial fluid-filled saclike structure surrounding the brain stem.1,2 This condition is thought to be the result of extensive brain necrosis secondary to a vascular insult involving the internal carotid arteries, which occurs after the brain and ventricles have been fully formed.1,2 Prenatal diagnosis of hydranencephaly is usually made in the second or third trimester of pregnancy, at which time the most striking sonographic findings include the detection of a brain cavity filled with anechoic fluid and preservation of the brain stem and posterior fossa structures.3

Because of the rarity of this disorder, almost all descriptions of the prenatal diagnosis of this condition are based on single case reports in fetuses presenting remote from the episode of cerebral stroke. In a few cases, serial scans illustrating the prenatal evolution are available,4–6 all demonstrating different sonographic features at presentation, including the identification of an admixture of dense

hemorrhagic and necrotic tissue, organized blood clots replacing the cerebral hemispheres, and an echoic intracranial cyst in the early second trimester. The aim of this report was to present our experience with the clinical and prenatal sonographic findings in cases of hydranencephaly diagnosed during the early stages of disease.

Materials and Methods

The protocol for this retrospective study was approved by the corresponding Institutional Review Boards. We identified 4 cases with similar appearances thought to represent hydranencephaly, all diagnosed during the second trimester of pregnancy at 2 Latin American fetal medicine referral centers. Information on maternal demographics, prenatal sonographic findings, antenatal courses, and pregnancy outcomes was obtained from the medical records, ultrasound reports, and referring obstetricians.

Results

The most relevant clinical and sonographic findings in our cases are presented in Table 1. The gestational age at the time of the diagnosis varied from 21 to 23 weeks. Two women were referred after their routine second-trimester scan showed a fetal brain abnormality in otherwise unremarkable pregnancies, although 1 of these patients had a history of drug abuse. The other 2 cases were diagnosed at the time of emergency obstetric consultation (late miscarriage in 1 and failed abortion with misoprostol and a subsequent suicide attempt with carbamate pesticide in the other). Two women were primigravidas, and 2 were multiparous with prior uncomplicated term pregnancies. None of patients had a previous early second-trimester scan in the current pregnancy.

Representative images from our cases are presented in Figures 1–3. Invariably, the most striking finding at presentation was the absence of cerebral hemispheres, which were replaced by homogeneous echogenic material filling almost all of the supratentorial space. In addition, it was possible to identify the cerebellum, thalami, brain stem, and portions of the choroid plexuses and the cerebral falx in all cases. The size of the fetal head, as determined by head circumference measurement, was within the normal range in all cases, whereas the transverse cerebellar diameter was below the fifth percentile for gestational age in 3 of the 4 cases. Color flow imaging revealed the presence of the circle of Willis in only 1 case. No associated extracranial abnormalities were detected by prenatal sonography in any of the cases.

Regarding pregnancy outcomes, 2 women underwent termination of pregnancy; 1 miscarried a stillborn neonate shortly after the scan; and 1 delivered at term with subsequent early neonatal death. In the ongoing pregnancy, a

Table 1. Fetal Hydranencephaly: Clinical Cases

<table>
<thead>
<tr>
<th>Case</th>
<th>MA, y</th>
<th>Parity</th>
<th>Reason for Referral</th>
<th>GA, wk</th>
<th>HC, mm</th>
<th>TCD, mm</th>
<th>Sonographic Findings</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>0</td>
<td>Abnormal fetal brain at second-trimester scan</td>
<td>23</td>
<td>212</td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Absent cerebral hemispheres; homogeneous material filling the supratentorial space, normal appearance of the cerebellum and brain stem, portions of the choroid plexuses and the cerebral falx identified</td>
<td>Drug abuse, TOP</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>0</td>
<td>Abnormal fetal brain at second-trimester scan</td>
<td>21</td>
<td>173</td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Same as in case 1 plus posterior aspect of the occipital cortex visible</td>
<td>Term delivery, early neonatal death</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>2</td>
<td>Threatened miscarriage, suspicion of holoprosencephaly</td>
<td>21</td>
<td>196</td>
<td>21</td>
<td>Same as in case 1 plus remnants of lateral ventricles, circle of Willis present</td>
<td>Miscarriage, post-mortem examination confirmed prenatal findings</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>2</td>
<td>Suicide attempt</td>
<td>23</td>
<td>218</td>
<td>20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Same as in case 1 plus remnants of lateral ventricles</td>
<td>Abortion attempt at 20 wk, suicide attempt at 23 wk, TOP</td>
</tr>
</tbody>
</table>

GA indicates gestational age; HC, head circumference; MA, maternal age; TCD, transverse cerebellar diameter; and TOP, termination of pregnancy.

<sup>a</sup>Values below the fifth percentile according to gestational age.
**Figure 1.** Case 2. A and B, Axial and sagittal views of the fetal head at 21 weeks' gestation. There is homogeneous echogenic material replacing the cerebral hemispheres. Note preservation of the thalami and cerebellum. C, Axial view of the fetal head at 23 weeks' gestation shows anechoic fluid filling the supratentorial space. Part of the posterior aspect of the occipital lobe is visualized. D, Sonographic view of the posterior fossa shows preservation of the cerebellum and cisterna magna. Both choroid plexuses and the cerebral falk are identified. E, Magnetic resonance imaging at 32 weeks. Sagittal and coronal views confirm the diagnosis of hydranencephaly.
Figure 2. Case 3. A and B, Coronal views of the fetal head at 21 weeks show dense, homogeneous material filling the supratentorial space. Portions of the cerebral falx and choroid plexuses are identified. C, Color flow imaging shows the patent basilar vessels feeding structures of the posterior fossa. D, The circle of Willis is visualized. E, Postmortem specimen shows absent cerebral hemispheres and preservation of the cerebellum and portions of the occipital cortex. The cerebral falx is also identified.
follow-up scan revealed the characteristic finding of an anechoic fluid-filled intracranial cavity 2 weeks after the diagnosis was made. Confirmation of the diagnosis was available in 2 cases, by magnetic resonance imaging at 32 weeks in 1 case and by postmortem examination in the other. No further investigations were performed in the 2 women who opted for termination of pregnancy.

Discussion

Hydranencephaly represents the most severe form of cortical destruction. It usually occurs in the fetal period but has also been reported in young children. The exact etiology is unclear, although the most accepted hypothesis is acute bilateral occlusion of the internal carotid arteries, with abrupt lack of a blood supply to the brain, leading to massive tissue necrosis and hemorrhage of the developing cerebral cortex. A similar pattern of anomalies was reproduced in animal models following ligation of both carotid arteries and jugular veins. The traditional prenatal sonographic findings include absence of the cerebral hemispheres and their replacement by a large anechoic fluid-filled intracranial space. In early stages of disease, however, the intracranial contents show uniform low-level echogenicity likely due to liquefied cerebral structures and blood, with a similar appearance to that of endometrioma fluid. This particular feature, noted in all of our cases, has been described only once previously in a report published more than 25 years ago. Another pathognomonic feature of hydranencephaly is the preservation of brain stem and posterior fossa structures, as seen in all of our cases. This finding is also explained by the perfusion of this area of the brain by the vertebral-basilar arterial system, which partially protects these lower midline structures from the vascular insult affecting the territory of the internal carotid arteries. Nevertheless, the visualization of the circle of Willis in 1 of our cases demonstrates that, at least in some cases, the internal carotid arteries could remain patent, and occlusion of the cerebral branches distal to the circle of Willis can occasionally lead to similar pathophysiologic events ending in massive brain destruction. Of note, the fetal head circumference was normal in all cases, but the cerebellum was noted to be hypoplastic in all but the case in which the circle of Willis was patent.

Main differential diagnoses that should be considered include severe hydrocephaly, alobar holoprosencephaly, and extreme forms of porencephaly and schizencephaly. In severe hydrocephaly, however, an intact rim of cortex surrounding the enlarged cerebral ventricles is always visualized. Distinguishing features of holoprosencephaly in-
clude microcephaly and fused thalami in association with facial abnormalities. In extensive forms of destructive processes such as porencephaly and schizencephaly, there are large areas of the brain in which normal cerebral tissue is identified. Another condition is Fowler syndrome, a rare autosomal recessive condition characterized by severe cortical atrophy and progressive destruction of central nervous system tissue due to a proliferative vasculopathy, leading to early fetal akinesia and arthrogryposis. As demonstrated by our cases, the sonographic appearances of hydranencephaly during the early stages of disease would be consistent with acute destruction of the cerebral cortex, giving it a characteristic homogeneously echogenic pattern within the cranial cavity representing blood and necrotic debris. Over time, this content is progressively replaced by more anechoic fluid as the result of progressive liquefaction of blood clots and brain tissue and continued production of cerebrospinal fluid by the choroid plexuses, leading to the classic sonographic appearance of hydranencephaly as seen at the end stages of disease.

Regarding the pathophysiologic mechanism, vascular occlusion may be triggered by local phenomena, such as thrombosis, necrotizing vasculitis, and proliferative vasculopathy, or acute vasoconstrictive events secondary to infection or toxic exposure. In the 2 of our 4 cases in which maternal substances abuse was known, it is possible that hydranencephaly occurred after the consumption of drugs known to produce encephaloclastic destruction, neurotoxicity, or vascular disruption. The other 2 women denied the use of any of illicit or toxic substances. Nevertheless, if substance use would be associated with hydranencephaly, the reason why only some fetuses exposed to these teratogenic drugs develop the disease and not others remains to be elucidated.

References