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# Sonographic Imaging of the Glycogen Stage of the Fetal Choroid Plexus

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At 8–22 weeks gestation, the lateral ventricular choroid plexus swells with glycogen deposits, which are thought to be an important source of anaerobic energy for a relatively hypovascular stage of brain development. Sonographic images during this phase demonstrate enlarged and echogenic ventricles, accounting for up to 80%–90% of the cerebral axial dimension in the earliest gestations studied. This increased echogenicity may be due to these glycogen stores. Because a rapid but sonographically definable decrease in the relative size of these structures occurs, routine imaging for the presence and character of the choroid plexus might prove to be a useful parameter in fetal examination.

Advances in sonographic gray scale technology have made it possible to document brain anatomy with increasingly greater detail. While current reports have focused attention on the normal and abnormal appearance of intracranial structures of the term and premature infant [1–3], this paper offers additional information concerning the early development of the telencephalic choroid plexus and a possible explanation for their somewhat unique sonographic appearance during the first trimester of embryogenesis.

On the basis of anatomic dissections of varying stages of stillborn and aborted human infants, three distinct stages of lateral ventricular choroid plexus have been recognized [4, 5]. During the initial stage, the cells of the choroid function as a blood-producing organ. According to the Kappers [4] study of 31 human embryos, this dramatically changes at about 7–8 weeks of age when the choroid cells begin to swell with intracellular deposits of glycogen. By week 12 of growth, the ventricles are said to be virtually filled with the glycogen-distended cells of the choroid. These minute anatomic dissections have suggested a persistence of the glycogen stage of the choroid to about week 22 of gestational growth. At this time or soon after, the choroid of the lateral ventricles again changes its appearance as the remaining glycogen stores further decrease and the organ histologically evolves into the cerebrospinal fluid-producing cells found in the later months of pregnancy. During this period of final maturation, the choroid recedes into the more posterior parts of the lateral ventricles.

## Subjects and Methods

To characterize the sonographic nature and appearance of the second, or glycogen, stage of the lateral ventricular choroid plexus, we undertook a prospective study of patients with early gestations up to a biparietal diameter of 6.0 cm. A total of 44 fetuses was included. Each was evaluated in terms of the echogenicity occurring within the ventricular outlines and the size of the echogenic structures relative to the measured distances of the falx to inner table of the skull. These factors were correlated with the measured biparietal diameter and thereby an estimated fetal age [6]. Commercially available Picker EDC and Toshiba real time units were used and images were recorded through the most prominent axial sections of the echogenic regions when seen.

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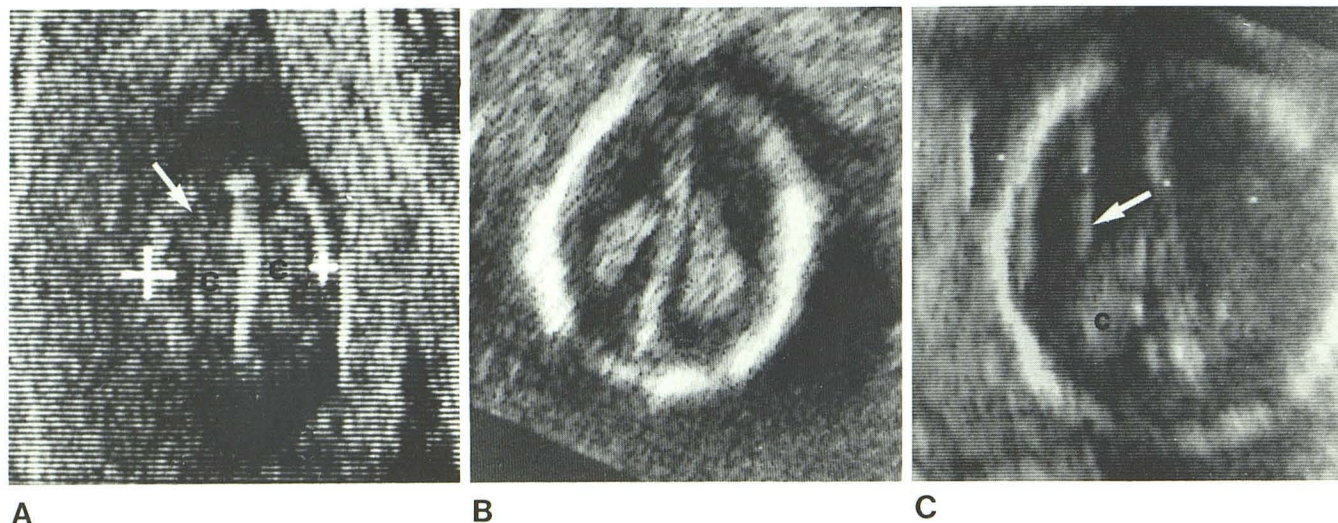


Fig. 1.—A, Axial view through early gestation (12.6–13.8 weeks). Bilateral echogenic choroid plexus (C) virtually fills lateral ventricles while only relatively thin rim of cerebrum (arrow) surrounds these structures. B, Another gestation (15–16 weeks). Echogenic choroid plexus fills telecephalic ven-

tricles, both accounting for smaller relative volume of cerebrum. C, 16.6–19.8 weeks gestation. Echogenic choroid plexus (C) recedes into more posterior parts of lateral ventricles, the fluid-filled lumen and boundaries of which are now sonographically visible (arrow).

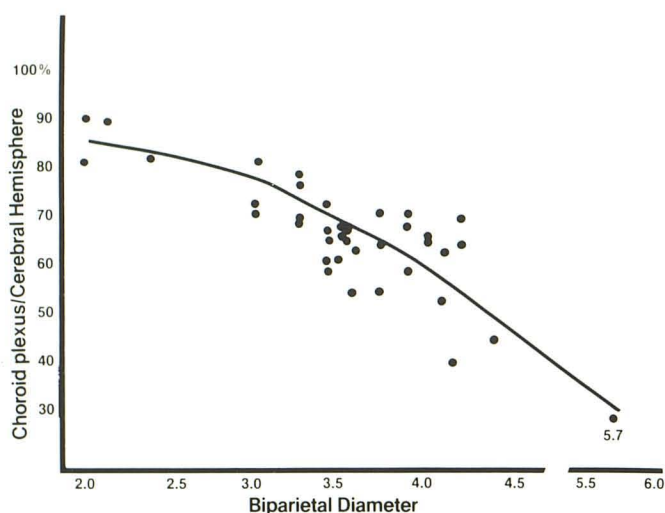


Fig. 2.—Ratio of choroid plexus measured in axial plane and falx to inner table of skull is plotted against measured biparietal diameter of 39 early gestations.

## Results

The biparietal diameters of the fetuses were 2–6 cm, indicating an estimated fetal age of 12–25.5 weeks. All subjects with biparietal diameters of 2.0–4.8 cm had bilateral echogenic areas imaged (fig. 1), conforming to the lateral ventricular contours. Four of five patients with a biparietal dimension of 4.8 cm or greater failed to demonstrate these structures (diameters were 4.8, 5.0, 5.5, and 6.0 cm), while one fetus with a 5.7 cm diameter had bilateral echogenic areas quite easily demonstrated. It was not possible to evaluate fetal intracranial anatomy below a biparietal diameter of 2 cm.

The echogenic regions were measured in the greatest axial plane. The ratio of the measurement and the surround-

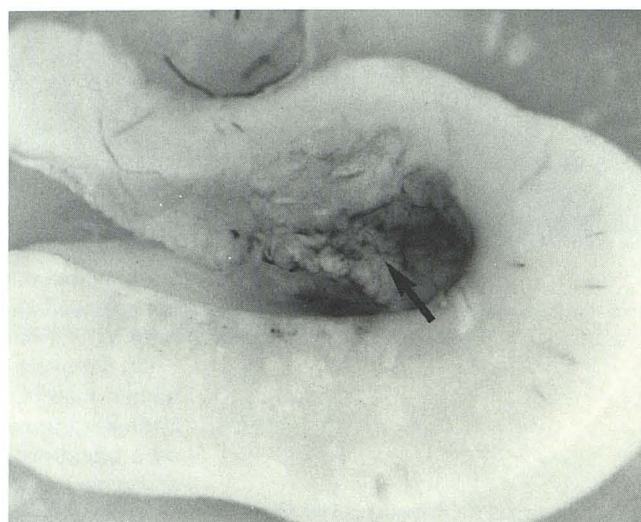


Fig. 3.—Even after shrinkage due to fixation, choroid plexus (arrow) fills ventricular lumen in partly disrupted coronal section of 16 week stillborn.

ing cerebral hemisphere demonstrated a dramatic change with fetal growth. These regions accounted for nearly 90% of the falx to inner skull measurement in the earliest fetuses studied (12 weeks) but rapidly decreased in relative size so that by 17 weeks they occupied only 60%–70%, and at 20 weeks about 50%–60%, of the cerebral hemisphere (fig. 2). In addition, with growth there occurred a relative posterior regression of the echogenic structures so that the ventricular wall could be distinctly seen when imaging was optimal (see fig. 1).

One stillborn infant included in this study came to autopsy 15 hr after an in utero sonographic study demonstrated the cerebral echogenic regions. Pathologic examination of the ventricles showed them filled with the choroid plexus in an anatomically normal 16 week fetus (fig. 3).

## Discussion

Denkhaus and Winsberg [7], and more recently Johnson et al. [8], have reported on the absolute and relative sizes of the ventricular system throughout fetal growth. Our study attempts to provide some additional information concerning the lateral ventricular echogenic appearance [8] often noted during early fetal life.

A unique stage of choroid plexus development at 8–22 weeks of gestation has been described by anatomists [4, 5]. During this period, the telencephalic choroid plexuses swell with intracellular glycogen deposits, distending the lateral ventricles. We observed bilaterally echogenic material within the lateral ventricles in all skulls 2.0–4.8 cm in biparietal diameter, but in only one of five patients with diameters greater than 4.8 cm. Therefore, it seems reasonable to propose that the increased echogenicity of the ventricles during the early weeks of embryogenesis is related to the choroid plexus [8], and specifically the glycogen stage of its development.

Since the energy stores of glycogen are thought to be essential to normal embryogenesis during a period when the brain is relatively hypovascular, and thus perhaps more dependent on energy release from glycogen without oxygen, the careful and detailed imaging of this structure might prove to be a most useful parameter in fetal examination. Further studies are needed in order to ascertain the signifi-

cance of failing to image the echogenic choroids, or perhaps finding its size below or above that which can be predicted for a given gestational age.

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