Sonographic Examination of the Fetal Vermis

Tricks for Obtaining the Narrow Midline Target With 3-Dimensional Volume Contrast Imaging in the C Plane

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Prenatal imaging of the fetal cerebellar vermis is challenging even for experienced examiners. We found that by aiming the ultrasound beam through the mastoid fontanel and then rotating the data set in a multiplanar reconstruction and applying volume contrast imaging in the C plane, we were consistently able to obtain images of the vermis in the standard midsagittal plane. Images of the fetal vermis suitable for morphologic evaluation were obtained in 408 of 414 cases (98.5%) at gestational ages of 18 weeks to 31 weeks 6 days; the examination time was only minimally increased.

Key Words—cerebellum; fetal vermis; multiplanar reconstruction; posterior fossa; 3-dimensional sonography; volume contrast imaging in the C plane

Received November 1, 2010, from the Department of Obstetrics and Gynecology, Hadassah–Hebrew University Medical Center, Jerusalem, Israel (O.S., S.Y., D.V.V.); Department of Obstetrics and Gynecology, Shaare Zedek Medical Center, Jerusalem, Israel (O.S., R.R.); and Department of Obstetrics and Gynecology, Chaim Sheba Medical Center, Tel Hashomer, Israel (Y.Z.). Revision requested November 22, 2010. Revised manuscript accepted for publication March 9, 2011.

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Imaging Approach

Imaging of the fetal vermis is an exceptional situation in which the degree of image degradation caused by reconstruction of a virtual sagittal plane from the acquired axial plane is offset by the improved image quality resulting from the large acoustic window available through the mastoid fontanel, coupled with 3-dimensional sonographic volume contrast imaging in the C-plane technology. We applied this approach to 414 consecutive cases from 18 weeks to 31 weeks 6 days that presented at 3 large tertiary centers. All sonographic examinations were performed by skilled operators (O.S., S.Y., and Y.Z.). Cases were a mix of routine scans and referrals but no cases with suspected brain anomalies. The vermis was successfully depicted in 408 of 414 cases (98.5%; Table 1), with less than 1 minute of additional scanning time. In 3 cases, the vermis could not be depicted satisfactorily because of morbid obesity, and in 3 others, visualization was unsatisfactory because of persistent inopportune fetal positioning.

Imaging of the fetal vermis is preferably performed between 18 and 32 weeks’ gestation. Vermian morphologic maturation is only completed at approximately 18 weeks, making reliable diagnosis of vermian dysgenesis difficult before this time in most cases. After 32 weeks, increased skull ossification and difficulty in directing the beam through the fontanel often adversely affect image quality. We use static volume contrast imaging with 3-dimensional multiplanar reconstruction (Volusion 730 Expert or E8; GE Healthcare, Kretz, Zipf, Austria; with 4- to 8-MHz transabdominal probes). Two-dimensional settings are fixed as follows: gray map, 7; dynamic contrast, 8; tissue harmonic, low; speckle reduction imaging, 2 to 5; reject, 50; optimized tissue imaging, normal; and enhance, 2. Three-dimensional settings using static volume contrast imaging are set as follows: quality, maximal; slice thickness, 2 to 5 mm; and volume angle as required by head size. An axial view is obtained at the level of the fourth cerebral ventricle. The beam is directed through the posterolateral (mastoid) fontanel to minimize shadowing. The head is usually viewed from a slightly posterior angle (Figure 2). During postprocessing (4D View software; GE Healthcare), the volume is rotated around the z-axis to align the brain midline to the horizontal. The reference dot is placed in the fourth ventricle; the vermis appears on the C plane, which displays the midsagittal section. The C plane is then enlarged and rotated to align the image spine-down and vertex-up. The vermis is now clearly displayed for evaluation (Figure 3).

Figure 4 shows a case in which the standard axial scan may have suggested an abnormal or absent vermis because a relatively wide connection can be seen between the fourth ventricle and cisterna magna in this 22-week fetus, when this connection is not usually present. The reconstructed sagittal scan clearly shows a structurally normal vermis that is slightly rotated upward. We were unable to show the normal vermis directly by scanning through the posterior fontanel. All examinations in this study were performed by highly skilled sonographers. However, we have found it easy to teach and to learn, and it has been adopted by less experienced operators as a routine approach in evaluating the vermis.
**Imaging Pitfalls**

The main pitfall in imaging the vermis lies in confusing it with one of the cerebellar hemispheres. The distinction is made by using 3 criteria:

1. The vermis has a characteristic appearance on the midsagittal plane. The fastigium, the median area of the fourth ventricle, has a typical triangular hypoechoic appearance. No such structure is present under the cerebellar hemispheres.

2. The vermian fissures appear as echogenic, thick, prominent lines extending from the convex surface of the vermis toward the fastigium. They should extend at least half the distance. This helps distinguish vermian fissures from the cerebellar folia, which are superficial and thinner, extending a short distance into the body of the cerebellar hemisphere. The vermian fissures become more prominent as gestation progresses and by 20 weeks assume a typical spoked wheel appearance.

3. In the midline, providing that a normal vermis exists, the tissue will be more echogenic than the substance of the cerebellar hemisphere as assessed in axial and coronal views. The vermis can also be compared to the hemispheres by using tomographic ultrasound imaging and displaying parallel sagittal slices (Figure 5).

An additional pitfall includes acoustic shadowing, which increases with gestational age, from the temporal and parietal bones. When created by shadowing, the defect will be present both in the midline and in the area of the cerebellar hemispheres. This pitfall can be avoided by imaging the posterior fossa from multiple directions. When the beam is directed through the acoustic window of the mastoid fontanel, shadowing is substantially reduced or avoided.

**Discussion**

There is no sharp histologic demarcation between the vermis and cerebellar hemisphere. The vermian lobules are separated by fissures running deep into the vermicial tissue. This is a major difference between the structure of the vermis and that of the cerebellar hemispheres. The cerebellar folia are relatively superficial and extend no deeper than one-third of the depth of the hemisphere. It is speculated that this deeper penetration by the vermian fissures with the leptomeninges and blood vessels as they are drawn between the fissures is the reason for the increased echogenicity of the vermis.

The literature concerning normal prenatal sonographic anatomy of the cerebellar vermis is confusing. The deep primary fissure separates the superior vermis from the larger inferior vermis and runs between the culmen lobule in the superior vermis to the declive lobule in its inferior part. The fissure has been depicted both as a hyperechoic structure and as an echoic one. Most studies of the vermis overlook this distinction. According to Zalel et al, the primary vermian fissure is visible in some cases at 18 weeks’ gestation and in all cases from 24 weeks onward. In an earlier study, the primary fissure was visible on transvaginal sonography not before 27 to 30 weeks. The striking difference between published prenatal nomograms of vermian length attests to the difficulty in correctly identifying and measuring it. We concur with Virals et al that volume contrast imaging facilitates acquisition and provides clear images of the vermis that allow for unambiguous distinction from the cerebellar hemispheres.

**Figure 2.** Orientation of a scan of the posterior fossa directed through the mastoid fontanel (arrow).
We have adopted and fine tuned the approaches as suggested by them and later by Pilu et al. In addition to the primary fissure, 9 vermian lobules, with 8 fissures separating them, may be visualized. They become increasingly visible on sonography with progressing gestation.

Since our previous publication, our cumulative experience has convinced us of the validity of the described method to confirm the presence of a normal vermis. The brain midline is a very narrow target, and we find that applying 3-dimensional sonography with volume contrast imaging in the C plane allows us to obtain it with consistent accuracy and minimal added examination time. We offer this approach as an added tool in the imaging armamentarium, as other authors have suggested useful clinical techniques for overcoming common scanning hurdles.

Correlations between prenatal sonography and postnatal imaging and fetal abnormalities are known to be poor for posterior fossa anomalies, with published discordance between prenatal diagnosis and postnatal abnormalities as high as 60%. This structured approach may aid in accurately identifying normal vermian anatomy and diagnosing abnormalities. Using this technique, the vermis is depicted satisfactorily in most cases for both morphologic evaluation and biometric assessment.
References


