

Picture of the Month

Visualization of the fetal optic chiasma using three-dimensional ultrasound imaging

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When an anterior brain abnormality such as septal agenesis is detected during fetal morphological examination, checking for the presence and the normality of the optic tract, in particular the optic chiasma, is an important prognostic factor^{1,2}. It was thought that the optic tract could only be visualized using nuclear magnetic resonance imaging, but the development of three-dimensional ultrasound has made it possible to image the optic chiasma in the second half of pregnancy³. We describe here our preliminary experience in visualization of the fetal optic chiasma in the second and third trimesters.

The optic chiasma is an 'X'-shaped structure lying in front of the cerebral peduncles and behind the wings of the sphenoid bone⁴. Doppler examination facilitates identification of the circle of Willis and its main components, including the emerging carotid arteries, the anterior and posterior communicating arteries, and the anterior and posterior cerebral arteries. The optic chiasma is 'intertwined' within this arterial circle, with the anterior branches crossing the anterior communicating arteries below the circle and the posterior branches passing underneath the posterior communicating arteries⁵. The other parts of the optic nerve, including the retrobulbar portion and the intraorbital pathway of the optic nerves, can be imaged relatively easily. In contrast, the portion located immediately in front of the chiasma cannot be imaged because it passes through bone (within the major wing of the sphenoid; Figure 1).

Using a Voluson 730 (versions BT 04 and 05, Kretztechnik – General Electric, Zipf, Austria) ultrasound machine, equipped with transabdominal (4–8-MHz) and transvaginal (5–9-MHz) volume probes, volume acquisition was performed as follows.

Transabdominal approach

Step 1 (Figure 2a): This approach starts from an axial plane parallel to and slightly below the biparietal diameter plane, showing the circle of Willis. An acquisition box is placed over the circle of Willis and the upper part of the cerebral trunk, within the limits of the perimeter of the skull.

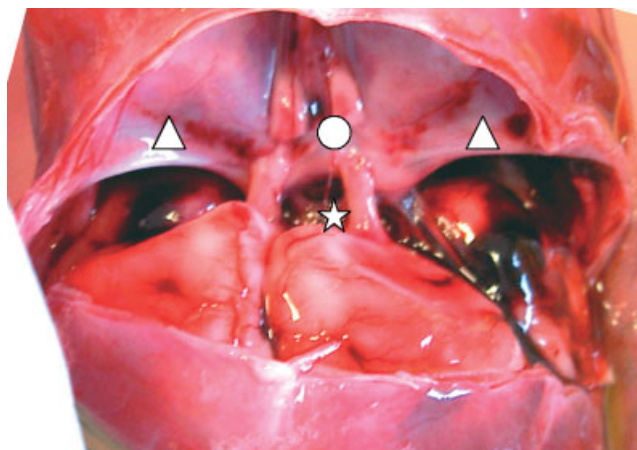


Figure 1 Anatomical demonstration of the optic chiasma (star) in relation to the wings of the sphenoid bone (triangles) and the sectioned olfactory bulbs (circle).

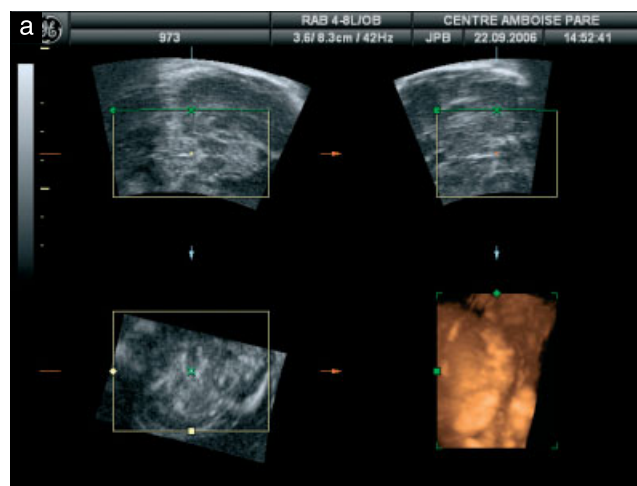


Figure 2 Successive steps in volume acquisition for three-dimensional reconstruction of the optic chiasma using transabdominal sonography (see text for description of parts a–e).

Step 2 (Figure 2b): A volume is obtained using the surface program set on 'maximum quality' and other

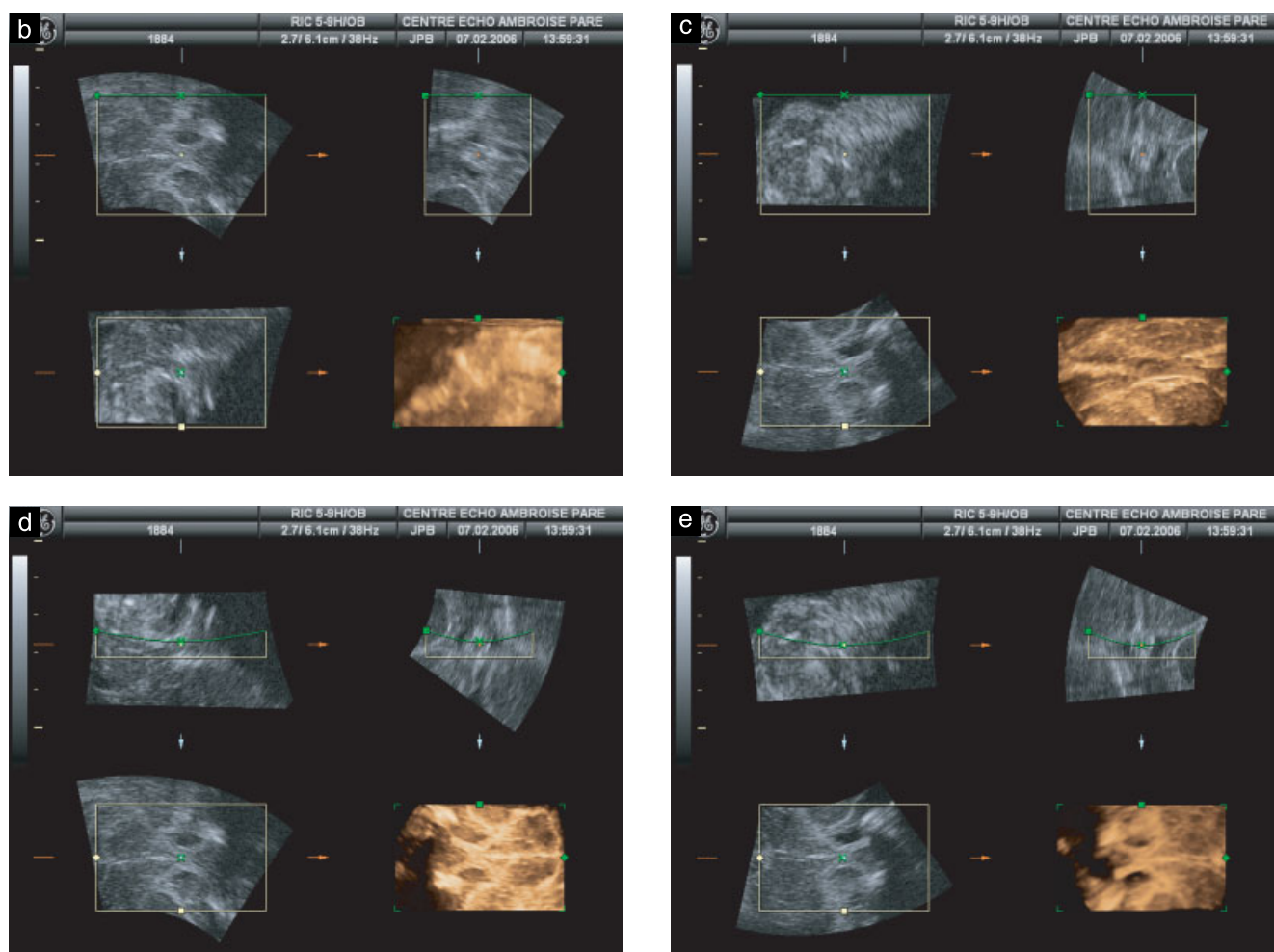


Figure 2 (Continued).

settings as follows: transparency, 30; threshold low, 30; threshold high, 255. A sweep is then performed in a sagittal plane with an angle of 30°.

Step 3 (Figure 2c): The volume acquired is then rotated 90°, showing the region of interest (ROI) from the top, in 'Plane A'. The ROI is oriented by placing the green line at the upper part of the box and the green square on the left.

Step 4 (Figure 2d): A convex reduction of the volume is performed in order to generate the thinnest possible volume.

Step 5 (Figure 2e): Scrolling from top to bottom allows the X-shaped chiasma to be visualized. The optimal rendering settings usually consist of the following combination: surface-smooth/gradient-light 70/30 set-up.

Transvaginal approach

This is used when the presentation is cephalic.

First, data are acquired by lateral scanning from the sagittal plane through an angle of 40°. Then, a thin slice is obtained in the same way as that described for the transabdominal approach (Figure 3).

On three-dimensional imaging, the optic chiasma appears as a hyperechoic structure (Figure 4), yet in the

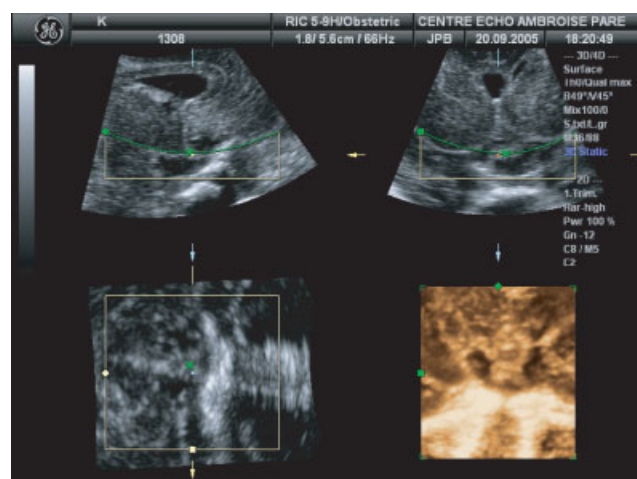


Figure 3 Transvaginal three-dimensional image demonstrating convex reduction of the volume to obtain the thinnest possible volume.

pediatric literature, the optic nerves have been described as being hypoechoic⁶. This is because, when they are studied by ultrasound during either the pre- or the postnatal period, they are usually imaged within the orbit, which is surrounded by markedly hyperechoic fat, rather than

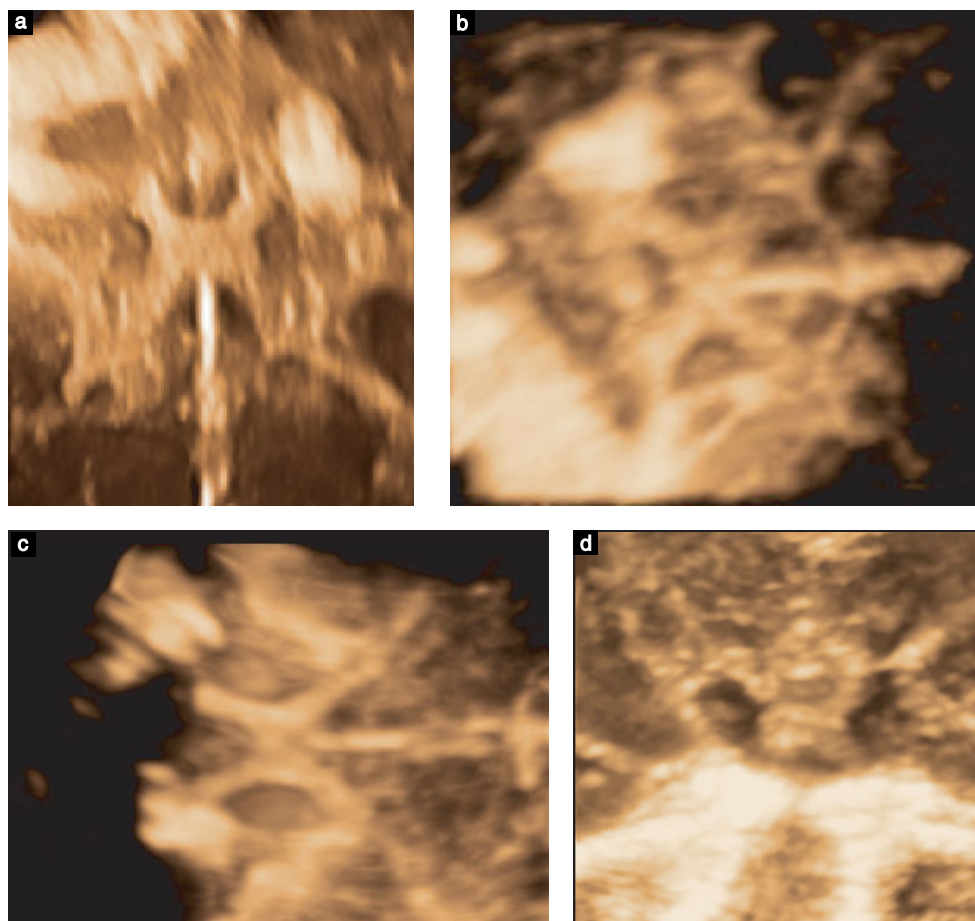


Figure 4 Examples of the sonographic appearance of the normal chiasma at (a) 22, (b) 24, (c) 29 and (d) 32 weeks' gestation. Figures (a–c) were obtained using a transabdominal approach and (d) was obtained using a transvaginal approach.

close to the chiasma, which is surrounded by water within the optochiasmatic cistern. Therefore, they show relative hypoechogenicity in comparison to the surrounding fat. In the work of Arita *et al.*⁶, the chiasma was imaged either before surgery, when under compression by a pituitary tumor, or immediately after pituitary tumor resection, i.e. not under normal physiological circumstances. It is likely that the echogenicity of the chiasma is modified by compression and an edematous environment.

References

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