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Assessment of the corpus callosum at 20–24 weeks' gestation by three-dimensional ultrasound examination

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KEYWORDS: corpus callosum; prenatal diagnosis; three-dimensional ultrasound

ABSTRACT

Objectives *To determine the range of positions of the fetal head in which a three-dimensional (3D) volume is acquired for subsequent successful imaging of the corpus callosum.*

Methods *We used 3D volumes of the fetal head obtained from singleton pregnancies at 20 to 23 + 6 weeks' gestation. The volumes, which had been acquired with the head in different positions, were then reconstructed with the objective of obtaining a mid-sagittal section of the brain to demonstrate the presence of the corpus callosum.*

Results *In the reconstructed mid-sagittal sections it was possible to demonstrate the corpus callosum in at least 90% of cases when the 3D volume acquisition plane was (1) mid-sagittal with the angle between the transducer and the direction of the fetal nose ranging from 0° to 179° and from 330° to 359°, (2) oblique around the crown–rump axis with an angle from the mid-sagittal plane of less than 30°, (3) oblique around the anteroposterior axis from the axial plane at the level of the biparietal diameter to the mid-sagittal plane or (4) axial at the level of the biparietal diameter with an angle between the transducer and the midline echo of the brain of 60–119°. In the mid-sagittal sections either the translucent corpus callosum or a comma-shaped echogenic structure was seen depending on whether the plane of volume acquisition was sagittal or axial.*

Conclusions *In 3D ultrasound examination the extent to which the corpus callosum can be demonstrated to be present is entirely dependent on the plane of volume acquisition. Copyright © 2007 ISUOG. Published by John Wiley & Sons, Ltd.*

INTRODUCTION

Prenatal sonographic diagnosis of agenesis of the corpus callosum is suspected by absence of the cavum septi pellucidi and presence of a teardrop configuration of the lateral ventricles in the standard biparietal diameter axial section of the fetal head[1]. However, definite diagnosis of partial or complete agenesis necessitates examination of a mid-sagittal plane of the brain with the transducer parallel to the direction of the genu of the corpus callosum, which is the same as the profile view of the face with the transducer parallel to the nose.

In transabdominal scanning acquisition of such a plane is often hindered by the position of the fetal head. The transvaginal approach is helpful in the vertex position but does not form part of the routine anomaly scan worldwide[2,3].

Three-dimensional (3D) ultrasonography offers the potential of acquiring a volume of the fetal head in any position and then, by reconstructing the image using the multiplanar technique, of obtaining the appropriate view for examination of the corpus callosum. However, a previous study examining the extent to which the nasal bone can be demonstrated to be present in a reconstructed section of a 3D volume concluded that this is dependent on the plane of volume acquisition[4].

The aim of this study was to determine the range of positions of the fetal head in which a 3D volume is acquired for subsequent successful imaging of the corpus callosum.

METHODS

This was a prospective study in 150 singleton pregnancies at 20 to 23 + 6 weeks' gestation. The patients attended our unit for a routine second-trimester ultrasound examination for fetal abnormalities and in all cases conventional ultrasound scanning had demonstrated the presence of the corpus callosum. In total, 469 3D volumes were acquired transabdominally (RAB 4-8L probe, Voluson 730 Expert; GE Medical Systems, Milwaukee, WI, USA) with the fetus at rest, with the

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following positions of the transducer in relation to the fetal head (Figure 1):

1. Mid-sagittal sections of the fetal profile with the angle between the transducer and the direction of the fetal nose ranging from 0° to 360°.
2. Oblique sections starting from the mid-sagittal plane of the fetal profile (0°) and rotating around the crown–rump axis to the coronal plane (90°).
3. Oblique sections with the transducer starting from the axial plane at the level of the biparietal diameter (0°) and rotating around the anteroposterior axis to the mid-sagittal plane (90°).
4. Axial sections at the level of the biparietal diameter with the angle between the transducer and the midline echo of the brain ranging from 0° to 180°.

The multiplanar mode of the 3D image was used to obtain the appropriate mid-sagittal section of the fetal brain for demonstration of the corpus callosum. The rate of successful demonstration of the corpus callosum for the different volume acquisition planes was determined.

RESULTS

Data on successful imaging of the corpus callosum after appropriate sectioning of the 3D volume of the head according to the initial plane of acquisition are shown in Table 1 and Figure 2.

When volume acquisition was in the mid-sagittal plane the appearance of the corpus callosum in the reconstructed images was that of a thin sonolucent strip with well defined echogenic contours overlying the cavum septi pellucidi[5]. When volume acquisition was in the axial plane at the level of the biparietal diameter, a comma-shaped echogenic structure (Figure 3), rather than a sonolucent strip, was evident in the reconstructed image where the corpus callosum is expected to be seen[5,6]. When volume acquisition was in the oblique planes, either the translucent corpus callosum or the comma-shaped echogenic structure was seen depending on whether the plane was closer to the mid-sagittal or the axial plane (Table 1).

For the purpose of this study visualization of the comma-shaped echogenic structure was considered

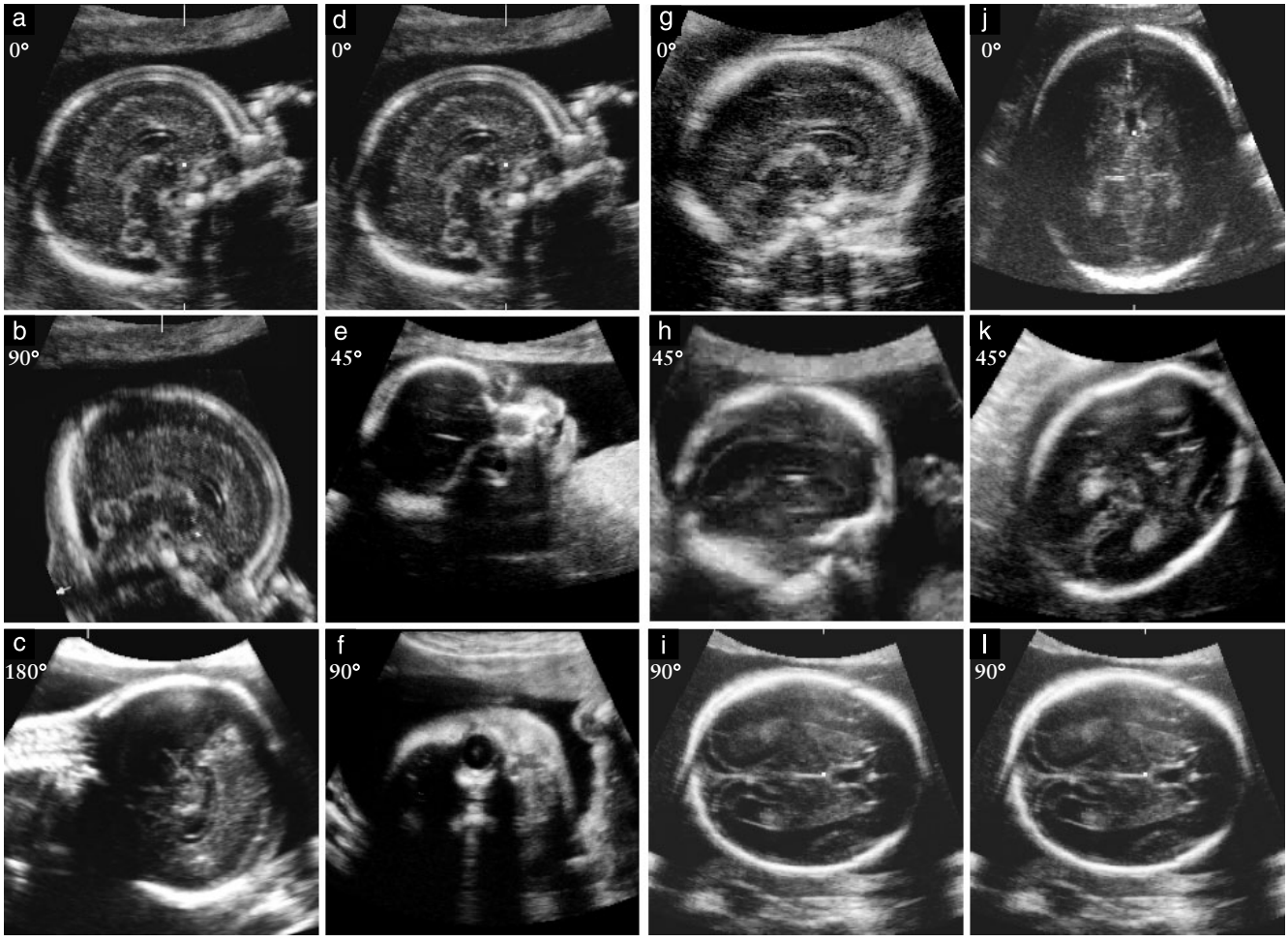

Figure 1 Ultrasound images showing planes of volume acquisition: (a–c) mid-sagittal sections of the fetal profile with the angle between the transducer and the direction of the fetal nose being 0°, 90° and 180°, respectively, (d–f) oblique sections around the crown–rump axis with the angle between the transducer and the mid-sagittal plane of the fetal profile being 0°, 45° and 90°, respectively, (g–i) oblique sections around the anteroposterior axis with the angle between the transducer and the axial plane at the level of the biparietal diameter being 0°, 45° and 90°, respectively and (j–l) axial sections at the level of the biparietal diameter with the angle between the transducer and the midline echo of the brain being 0°, 45° and 90°, respectively.

Table 1 Successful visualization of the corpus callosum after appropriate sectioning of the three-dimensional volume of the head according to the initial plane of acquisition

Acquisition plane	n	*Corpus callosum*	
		Seen (%)	*Appearance*
Mid-sagittal with rotation of 0–179° from the direction of the nose (0°)	72	67 (93)	Translucent
Mid-sagittal with rotation of 180–299° from the direction of the nose (0°)	49	0 (0)	—
Mid-sagittal with rotation of 300–329° from the direction of the nose (0°)	12	6 (50)	Translucent
Mid-sagittal with rotation of 330–359° from the direction of the nose (0°)	21	19 (90)	Translucent
Oblique with rotation of 0–29° around the crown–rump axis from the profile (0°)	22	22 (100)	Translucent
Oblique with rotation of 30–59° around the crown–rump axis from the profile (0°)	28	4 (14)	Echogenic
Oblique with rotation of 60–90° around the crown–rump axis from the profile (0°)	23	13 (57)	Echogenic
Oblique with rotation from axial (0°) to 29°	17	16 (94)	Echogenic
Oblique with rotation from 30° to mid-sagittal (90°)	26	24 (92)	Translucent
Axial at the level of biparietal diameter with rotation of 0–29°	31	13 (42)	Translucent
Axial at the level of biparietal diameter with rotation of 30–59°	39	5 (13)	Translucent
Axial at the level of biparietal diameter with rotation of 60–119°	79	75 (95)	Echogenic
Axial at the level of biparietal diameter with rotation of 120–180°	50	30 (60)	Translucent

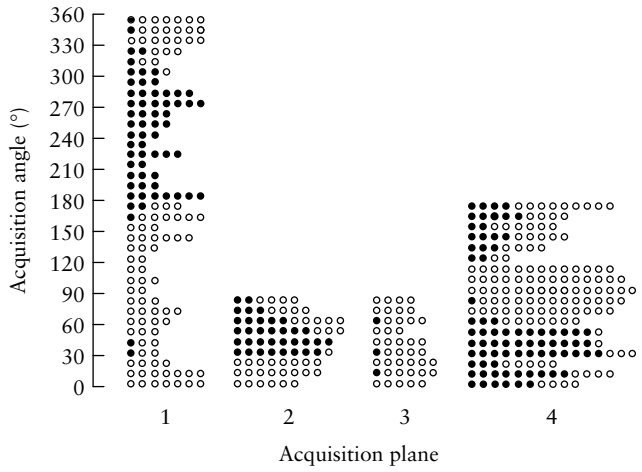

Figure 2 Ability to demonstrate the corpus callosum (○, seen; ●, not seen) in the reconstructed mid-sagittal section in cases where the volume acquisition plane was (1) mid-sagittal with rotation of 0–359° from the direction of the nose (0°), (2) oblique with rotation of 0–90° around the crown–rump axis from the profile (0°), (3) oblique with the transducer starting from the axial plane at the level of the biparietal diameter (0°) and rotating around the anteroposterior axis to the mid-sagittal plane (90°), and (4) axial at the level of the biparietal diameter with rotation of 0–180°.

to constitute successful demonstration of the corpus callosum.

DISCUSSION

In the assessment of the corpus callosum by two-dimensional ultrasound examination it is necessary to obtain a mid-sagittal view of the fetal brain with the genu of the callosum being parallel to the transducer. In the case of 3D ultrasound imaging there is an erroneous belief that, irrespective of the position of the head, a volume can be obtained and that after appropriate manipulation any desired structure can be identified. The present data show that the extent to which a given structure, such as the corpus callosum, can be demonstrated to be present on 3D ultrasound examination is entirely dependent on the plane of volume acquisition.

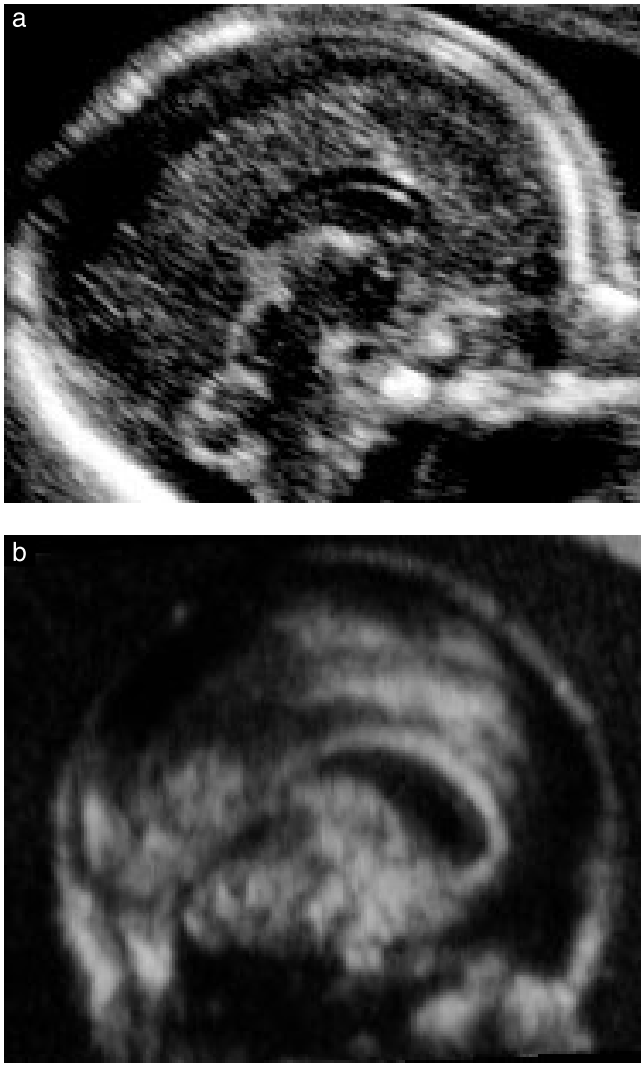

Figure 3 Ultrasound images showing sonolucent (a) and echogenic (b) appearance of the corpus callosum depending on whether the volume acquisition was in the mid-sagittal or axial plane.

The appearance of the corpus callosum in the reconstructed image is also dependent on the plane of volume acquisition. Thus, in the mid-sagittal planes the corpus callosum is seen as a thin sonolucent strip with well defined echogenic contours, whereas in the reconstructed mid-sagittal sections from axial acquisition planes the corpus callosum is not seen but there is a comma-shaped echogenic structure overlying the cavum septi pellucidi instead. This echogenic structure is thought to represent the interface between the cingulate gyrus, cingulate sulcus, cerebrospinal fluid and the blood flow in the callosal arteries[6].

The findings of this study show that, if the fetus is facing up towards the transducer, the corpus callosum can be demonstrated unless the head is hyperextended. When the fetus is facing laterally, it is possible to demonstrate a comma-shaped echogenic structure after acquisition of a volume of the head at the level of the biparietal diameter and appropriate reconstruction of the mid-sagittal plane. This has also been reported in a study of 202 fetuses at 20–24 weeks in which a 3D volume was acquired in the axial plane and after reconstruction of the sagittal section it was possible to visualize the corpus callosum in 98% of cases[7]. However, it was not possible to demonstrate the corpus callosum in the mid-sagittal plane with the angle between the transducer and the midline echo of the brain between 180° and 299° or in the reconstructed mid-sagittal section in cases where the volume acquisition plane had been oblique in the crown–rump axis with an angle from the mid-sagittal plane of 30–59°, or in the axial biparietal diameter with an angle between 30° and 59°.

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