REVIEW ARTICLE

Imaging Small Fetal Parts by High-resolution Ultrasound

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Abstract

Recent technological innovations in ultrasound diagnostic equipment have made it possible for us to obtain ultrasound images of detailed parts such as small organs in fetuses. It may thus be confusing when we come upon small fetal parts that were previously unrecognizable with conventional ultrasound equipment. Therefore, we need to cultivate an understanding of small fetal parts and the fetal-specific anatomy that accompanies fetal development while using high-resolution ultrasound equipment. This review article introduces ultrasound images of small fetal organs visualized with high-resolution ultrasound.

Keywords: High resolution, Single crystal, Small fetal parts.

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Introduction

Ultrasound imaging technology has remarkably improved and aided in our evaluation of fetal morphology. In particular, small fetal organs that were previously invisible can now be observed using high-resolution ultrasound.

Fetuses have unique morphological features not found in adult humans due to still being in the developmental stage of life. Typical organs different from adults include the central nervous system, thymus, and adrenal gland. The fetal central nervous system undergoes dramatic changes as the fetus develops, and the thymus and adrenal glands are significantly larger in fetuses than in adults.

This review article describes several fetal organs now able to be visualized with high-resolution ultrasound equipment that are not often noticed in clinical practice.

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Ultrasound Equipment

Ultrasound images were generated using a high-resolution transabdominal transducer (Voluson E10® with C2-9D, RM7C; GE Health Care, Milwaukee, WI, USA). Single crystals are used as oscillators for these transducers. Compared with conventional polycrystalline oscillators, single-crystal oscillators can visualize ultrasound images with not only high resolution but also high penetration.

Thymus

During the fetal period, the thymus is a relatively large organ that extends upward from the superior thoracic opening to the base of the neck. The thymus regresses somewhat from childhood to puberty and is almost invisible by adulthood due to fat infiltration into the cortex.[1]

The fetal thymus is visualized as a quadrangular structure in front of the three vessels at the level of the three-vessel view.[2] It is difficult to distinguish between the thymus and lungs using conventional ultrasound equipment, but the two can be clearly distinguished using high-resolution ultrasound equipment.

Figure 1 shows a fetal thymus at 29 weeks of gestation. The thymus is visualized slightly less brightly than the lungs. A coarse, fine, linear, and high-intensity echo can be seen inside the thymus. The size of the fetal thymus is significantly correlated with gestational age, and multiple two-dimensional (2D) sonographic measurements of the fetal thymus have already been reported.[3–6] Furthermore, the thymus volume calculated by three-dimensional (3D) ultrasound has also been reported.[2]

The fetal thymus is often misdiagnosed as a mediastinal tumor if its characteristics are unrecognized by the examiner.

Adrenal Glands

The fetal adrenal glands are 10–20 times larger than the adult adrenal glands in terms of body weight. The substantial size of the fetal adrenal glands is due to the large fetal zone, which is the fetal cortex. The fetal adrenal glands lose about two-thirds of their weight in the first few weeks after birth. The fetal adrenal cortex shrinks markedly in the first year of life, whereas the adrenal medulla remains relatively small after birth.[7]

Figure 2 shows a fetal right adrenal gland at 38 weeks of gestation. The adrenal gland is depicted in a leaf-like manner on axial sections, with the central medulla depicted in high brightness and the fetal cortex depicted in low brightness. Although the adrenal glands shrink after birth, the fetal adrenal gland is significantly correlated with gestational age.[8–10]

Pancreas

Figure 3 shows a fetal pancreas at 27 weeks of gestation. Visualization of the pancreas by ultrasound in adults is relatively difficult due to the influence of the surrounding bowel air. In fetuses, there is no air around the pancreas, so it is easier to visualize than in adults, but visualization is still difficult because the brightness with the surrounding tissue is similar. The visualization rate of the

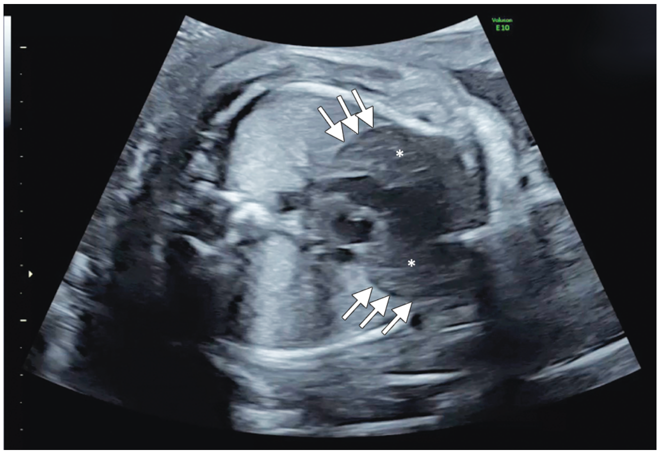

Fig. 1: Image at 29 weeks of gestation. The fetus in the three-vessel view is shown. The thymus (*) is visualized less brightly than the lung. The borderline between the lung and thymus is sharp (arrows)

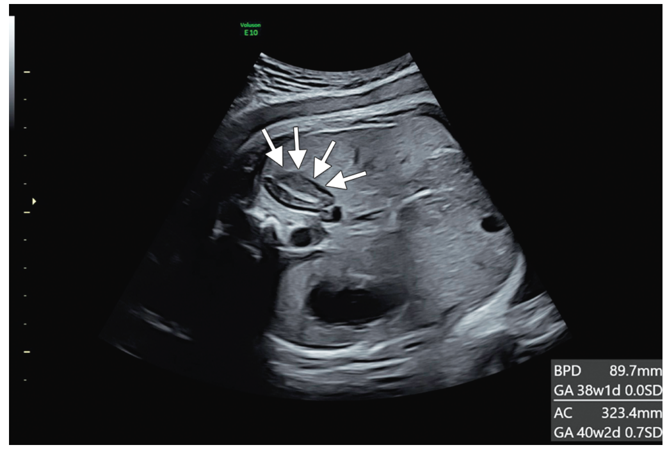

Fig. 2: Image at 38 weeks of gestation. The fetal right adrenal gland (arrows) is visualized in the axial section just below the point of measuring the abdominal circumference. The cortex is visualized at low brightness, and the medulla is visualized at high brightness

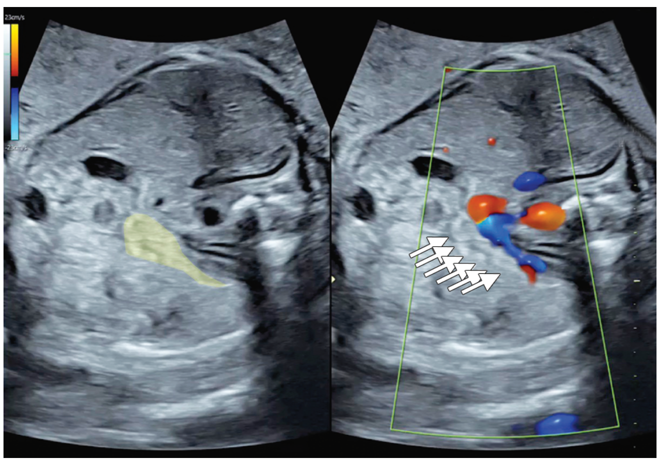

Fig. 3: Image at 27 weeks of gestation. The left image was obtained in B mode; the pancreas is located in the yellow-shaded area. The right image was obtained in color Doppler mode; the spleen blood vessels are visualized. The pancreas (arrows) is located ventral to the splenic blood vessels

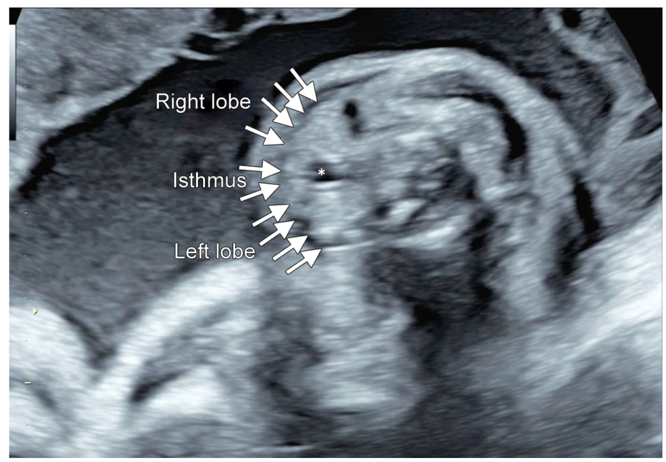

Fig. 4: Image at 25 weeks of gestation. Axial section of the neck. The thyroid is visualized as a high-brightness structure (arrows). *indicates the trachea

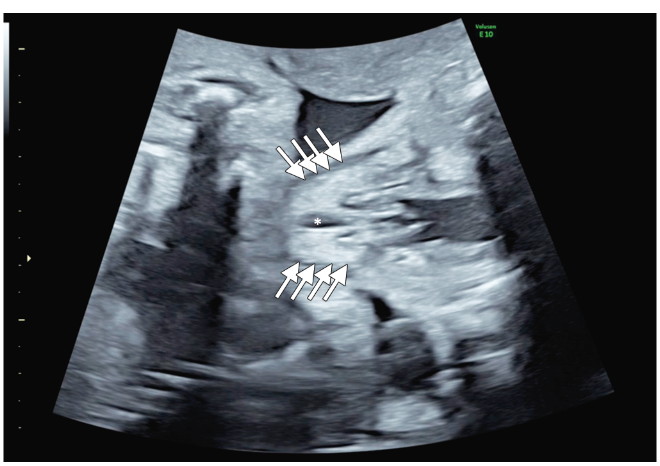

Fig. 5: Image at 25 weeks of gestation. Coronal section of the neck. The thyroid is visualized as a high-brightness structure (arrows). *indicates the trachea

fetal pancreas has been reported to be approximately 60%.[11] The fetal pancreas size is significantly correlated with gestational age.[12] In axial sections, the spleen blood vessels are a marker for finding the pancreas. The pancreas is visualized on the ventral side of the splenic blood vessels with a slightly higher brightness than the surrounding tissue.

Thyroid

Figures 4 and 5 show a fetal thyroid gland at 25 weeks of gestation in the axial view and coronal view, respectively. The thyroid isthmus is located in front of the trachea, and the thyroid lobes are located on either side of the trachea. They are visualized as a high-brightness structure. Two-dimensional sonographic measurements of the fetal thyroid, as well as the volume, have been reported for a relatively long time.[13–17] Since the thyroid gland can be clearly visualized with high-resolution ultrasound, it is expected that more accurate measurements will be obtained in the future.

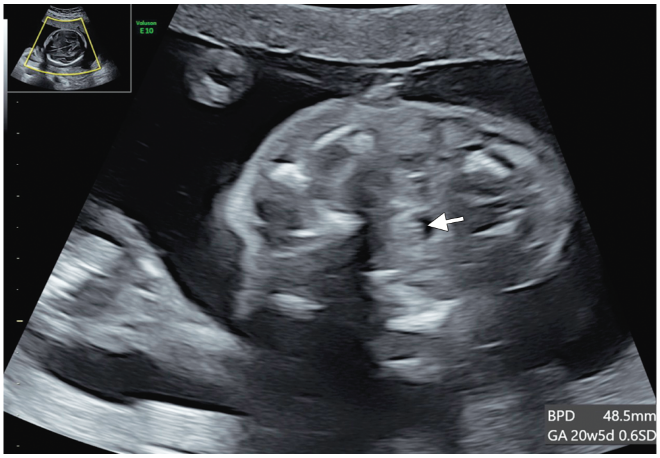

Fig. 6: Image at 20 weeks of gestation. The axial section at the visible height of the nasopharynx. The fetal uvula is visualized in the nasopharynx as an "equal sign" (arrow)

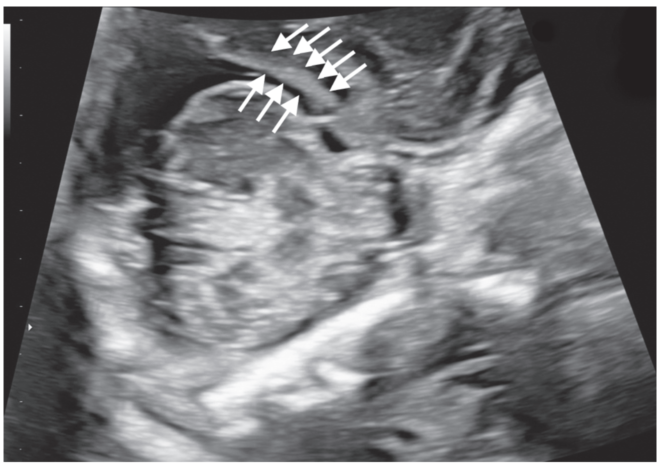

Fig. 8: Image at 27 weeks of gestation. Transcerebellar section. The trigeminal nerve is located in the subarachnoid space and visualized as a bright cord (arrow)

Uvula

The fetal uvula is a very small structure, but it can be visualized with ultrasound. The uvula is visualized as an equal sign, and the absence of an equal sign has been reported to aid in the diagnosis of cleft palate.[18,19] Figure 6 shows the fetal uvula in an axial section at the level of the nasopharynx. The uvula is easily observable when amniotic fluid is present in the pharynx.

Parotid Gland

Figure 7 shows a fetal parotid gland at 25 weeks of gestation. The parotid gland is visualized as a circular structure with relatively high brightness. Familiarity with the location and normal imaging findings of the fetal parotid gland may help diagnose parotid tumors.

The fetal parotid gland has received little attention, so there are no reports of its measurements.

Trigeminal Nerve

The trigeminal nerve is the largest of the cranial nerves. It exits the brain from the lateral edge of the pons. Figure 8 shows a fetal trigeminal nerve exiting Meckel's cave at 27 weeks of gestation in the axial transcerebellar plane.

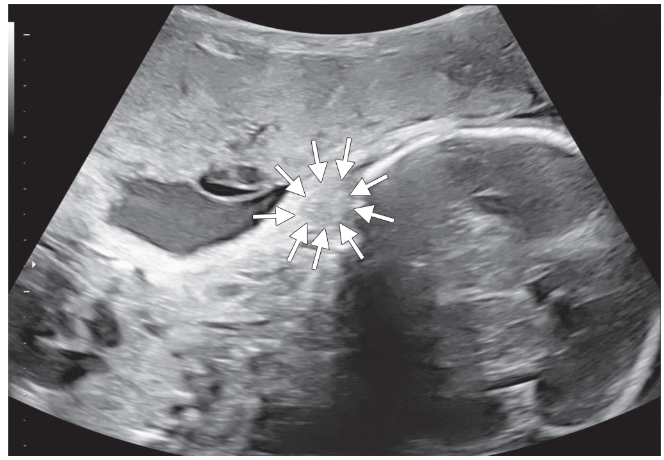

Fig. 7: Image at 25 weeks of gestation. Coronal section. The parotid gland is visualized slightly less brightly than the surrounding tissue

Conclusion

Advances in ultrasound diagnostic equipment have made it possible to visualize small fetal organs that were previously invisible. Since the morphology of fetal organs differs from that of adults due to fetuses still developing, we need to be familiar with fetal-specific morphologies. By observing fetal organs, including the small parts, we can better understand the development and anatomy of normal fetuses.

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