Targeted fetal neurosonographic examination by transabdominal approach

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Introduction

Recent ISUOG guidelines addressed reliability, indications and methods of targeted neurosonographic examination of the fetal central nervous system. ISUOG recommends the transvaginal approach when the fetal head is positioned in the pelvis and can be reached properly with an endocavitary probe. However, with twin pregnancies or when the fetus is in breech presentation, which often occurs at an earlier gestational age (e.g., week 19–20), the transvaginal approach is not always possible. In these cases, ISUOG suggests using high-resolution linear or microconvex transducers with a frequency range reaching 8–9 MHz at the upper end. Fortunately, state-of-the-art ultrasound technology offers high-resolution/high-frequency convex transducers for transabdominal examinations of the fetus in breech presentation that provide excellent image quality.

Methods and Material

Neurosonographic examinations on a large number of fetuses in breech presentation were performed transabdominally using a high-frequency convex probe (PVT-574BT) connected to an Aplio a550 ultrasound system. Orthogonal axial, sagittal, parasagittal and coronal scan planes were identified. The transabdominal approach detected fetal brain malformations, in particular defects of midline structures such as the corpus callosum. Different color-coded modes available on the Aplio, e.g., standard Color Flow Mapping (CFM), Advanced Dynamic Flow (ADF) and Superb Micro-vascular Imaging (SMI) were used to visualize brain vascularization.

Advanced Dynamic Flow

Advanced Dynamic Flow (ADF) elevates color Doppler imaging to a whole new level of spatial resolution to reveal minute vasculature with unprecedented accuracy and detail. ADF provides high frame rates, while maintaining the full B-mode image quality.

Superb Micro-vascular Imaging

Superb Micro-vascular Imaging (SMI) moves beyond conventional color Doppler technology by applying a unique algorithm allowing visualization of small vessels with low velocity, while maintaining high resolution, minimal motion artifacts and high frame rates. Traditional color Doppler imaging removes clutter from the images by suppressing low velocity components, resulting in a loss of flow in tiny vessels. SMI separates flow from overlaying tissue motion effectively, while preserving even the subtlest low-flow components with unmatched detail and definition. Canon's innovative SMI technology expands the range of visible blood flow and provides visualization of low velocity micro-vascular flow unseen before with ultrasound. SMI's level of vascular visualization, combined with high frame rates, advances diagnostic confidence. By removing anatomical background information, the monochrome mode reveals the finest vasculature with high sensitivity. Color-coded SMI demonstrates flow and greyscale information with high temporal and spatial resolution simultaneously.

Results and Findings

Equipment: The high-frequency probe was appreciated first of all for its ease of use due to its shape and low weight as well as the light weight of the connection cable which reduced operator fatigue. The very wide ultrasound bandwidth allowed successful examination even in overweight pregnant women with good results.

Images: In B-mode, fetal brain structures in fetuses of week 19-21 were analyzed with increased operator confidence due to the improved image performance of the probe. The brain structures obtained in the individual scan planes are presented with excellent resolution and contrast and an optimal signal-to-noise ratio (Fig. 1).

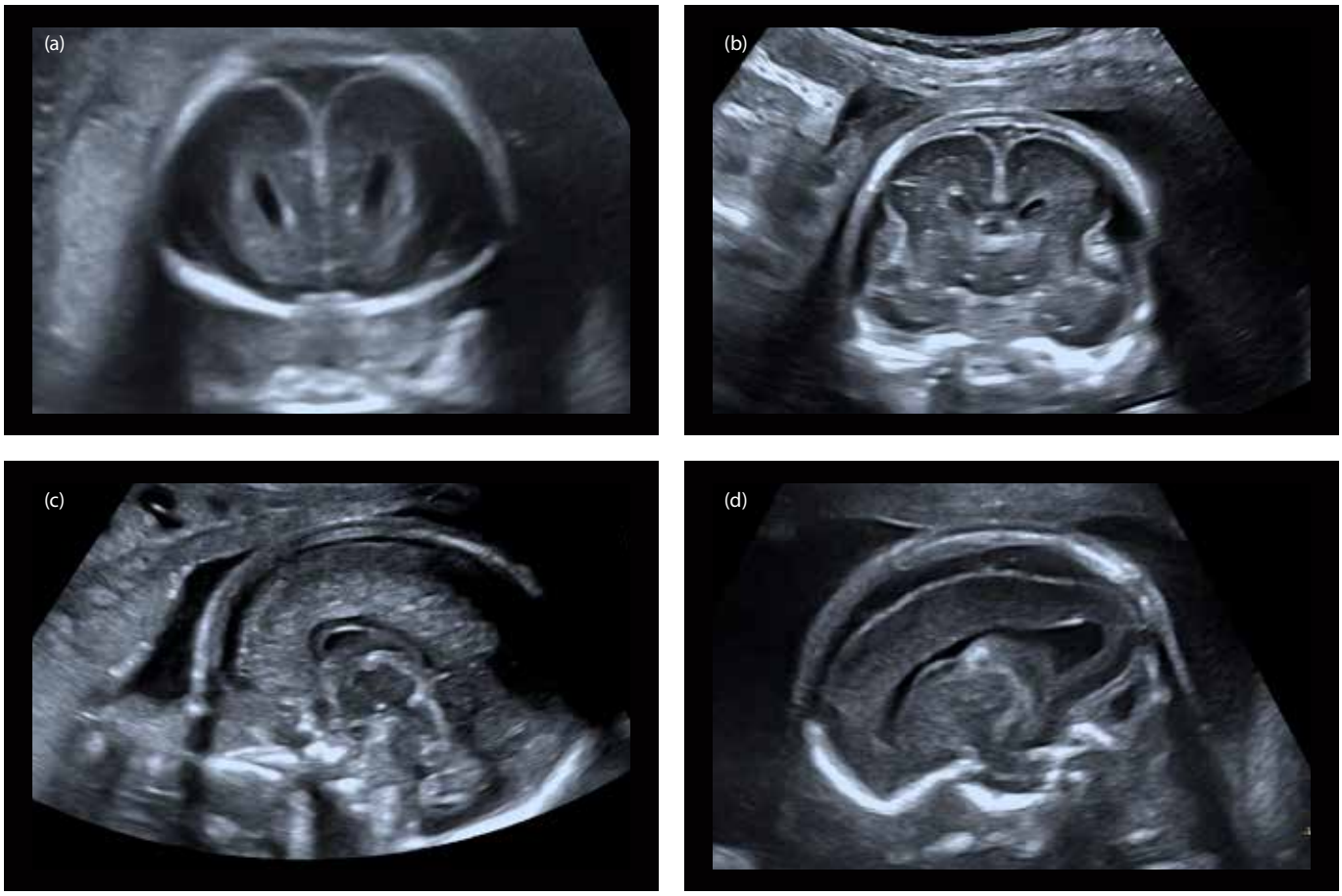

Figure 1 Fetal brain at 19-20 weeks of gestational age:
a) and b) Coronal scans of the fetal brain
c) Median sagittal scan with visualization of the corpus callosum and the cerebellar vermis
d) Oblique parasagittal scan (visualization of the lateral ventricle, choroid plexus and cerebral parenchyma)

Images obtained in the same fetus demonstrate the use of the various color Doppler modalities available on the Aplio platform. SMI has proved to be an excellent imaging modality to not only precisely visualize the main cerebral arteries and veins, but also show the vascular branches of very small caliber with remarkable accuracy and at a very high frame rate (Fig. 2).

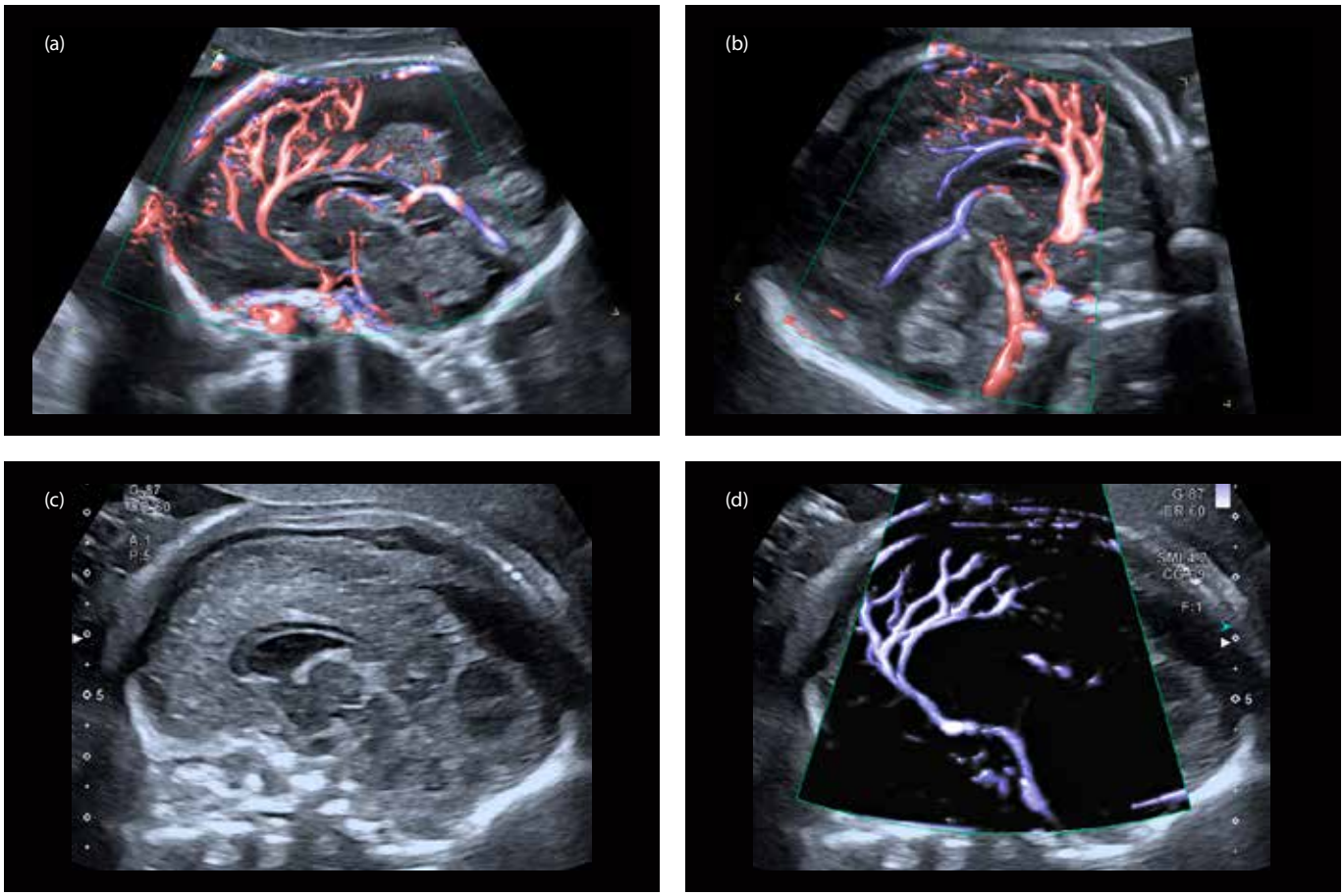

Figure 2 Normal fetal brain at 20 weeks of gestational age:
a) and b) Sagittal scans of the fetal brain using ADF; the pericallosal artery and its branches as well as the vein of Galen are visible
c) and d) TwinView of median sagittal scan with visualization of the corpus callosum and SMI vascularization

In our experience, the use of the high-frequency convex probe has proved to be very useful in the study of anomalies of the corpus callosum (complete agenesis, partial agenesis). It obtained a high level of detail when examining the midline and the surrounding brain structures (cerebral parenchyma, cerebral cortex) and yielded truly informative images (Figs. 3 and 4).

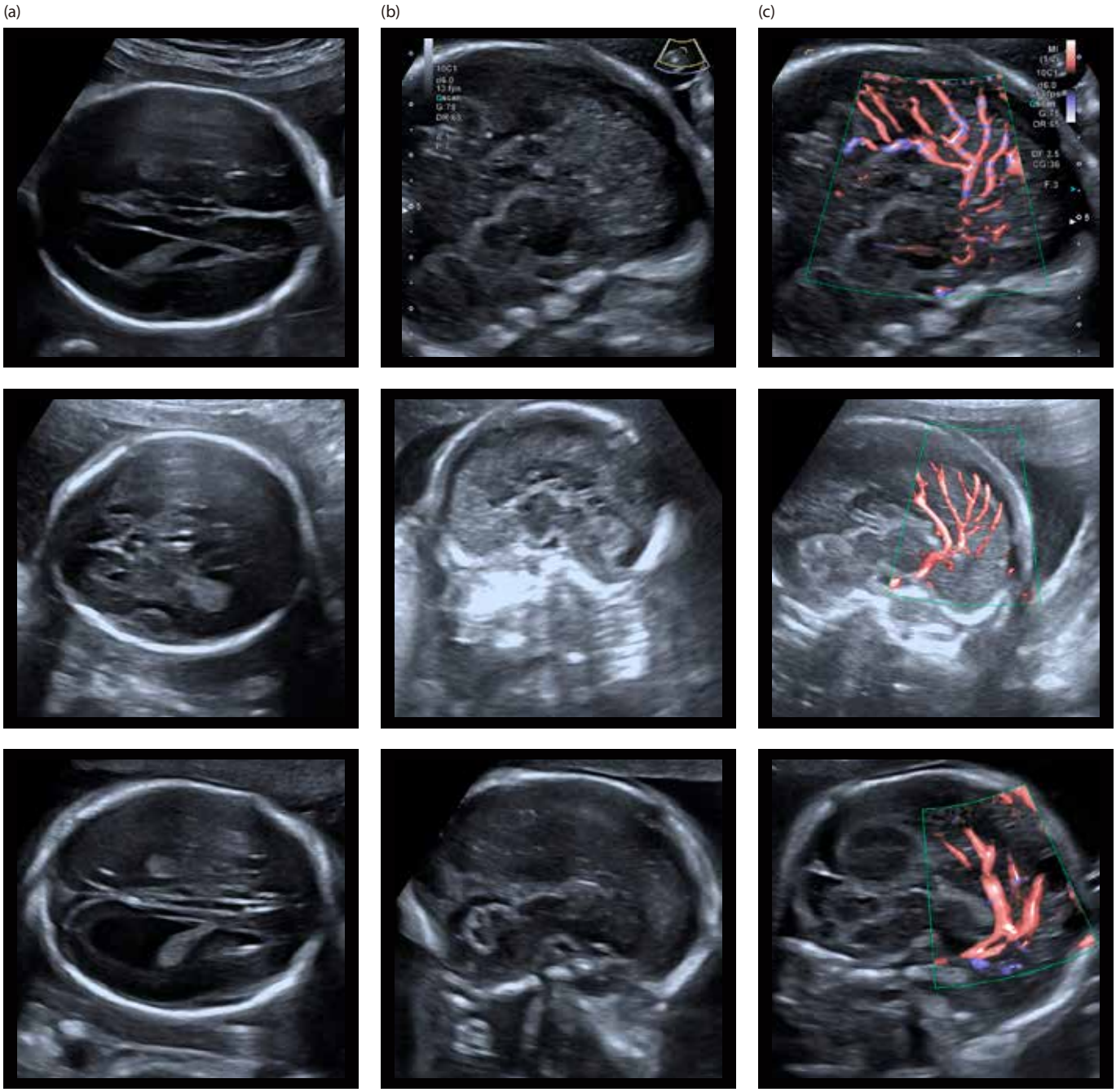

Figure 3 Three cases of complete agenesis of the corpus callosum; from left to right:
a) Axial scans of the brain with indirect signs of the disease (no evidence of the cavum septum pellucidum cavity, colpocephaly)
b) Median sagittal sections (the corpus callosum is not detectable)
c) Absence of the normal semicircular course of the pericallosal artery with radiated arrangement of the branches of the anterior cerebral artery (ADF and SMI)

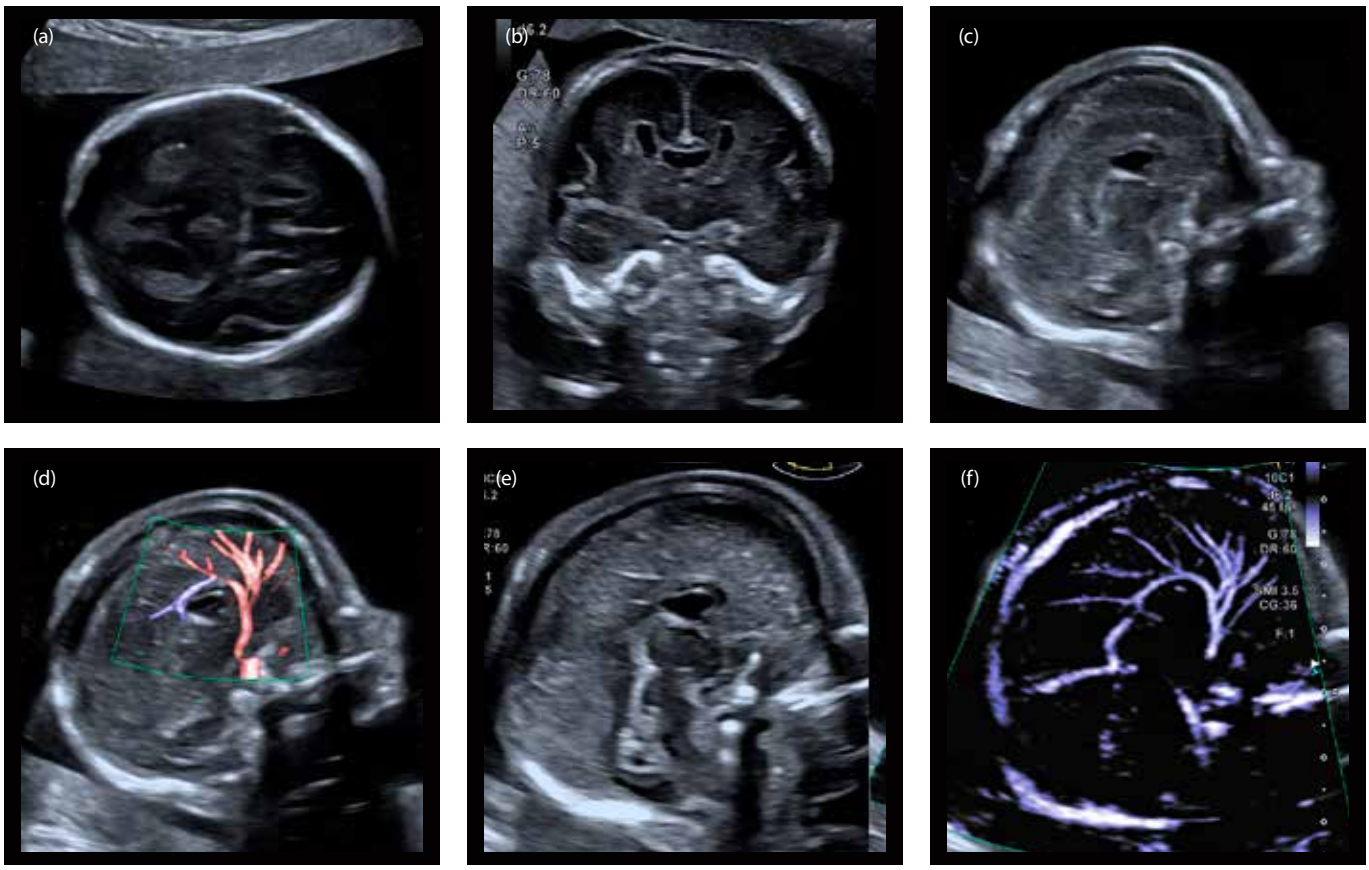

Figure 4 Partial agenesis of the corpus callosum:
a) Axial section of the fetal brain (presence of dysmorphic cavum septum pellucidum)
b) Coronal section of the fetal brain (presence of dysmorphic cavum septum pellucidum)
c) Sagittal section of the brain: corpus callosum viewable only in its anterior portions (absence of the splenium)
d) Median sagittal section with ADF
e) and f) TwinView of median sagittal section with visualization of anterior portion of the corpus callosum and SMI showing abnormal length of the pericallosal artery

Conclusion

The Aplio ultrasound system equipped with a high-frequency convex probe is today, in our opinion, one of the best performing solutions for ultrasound diagnostics in obstetrics in general and in particular for the study of the fetal brain and its malformations. Our experience supports the ISUOG recommendation by confirming that high-resolution probes are a valid alternative to the endocavitary approach for neurosonographic examination when the fetus is in breech presentation.

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The clinical results described in this paper are the experience of the author.
Results may vary due to clinical setting, patient presentation and other factors.

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