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Normal and abnormal fetal brain development during the third trimester as demonstrated by neurosonography

G. Malinger*, D. Lev, T. Lerman-Sagie

Fetal Neurology Clinic, Department of Obstetrics and Gynecology, Genetics Institute and Pediatric Neurology Unit, Wolfson Medical Center, Holon, Sackler School of Medicine, Tel-Aviv University, Tel-Aviv, Holon 58100, Israel

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Abstract

The multiplanar neurosonographic examination of the fetus enables superb visualization of brain anatomy during pregnancy. The examination may be performed using a transvaginal or a transfundal approach and it is indicated in patients at high risk for CNS anomalies or in those with a suspicious finding during a routine examination. The purpose of this paper is to present a description of the normal brain and of abnormal findings usually diagnosed late in pregnancy, including malformations of cortical development, infratentorial anomalies, and prenatal insults.

Keywords: Ultrasound; Prenatal diagnosis; Third trimester; Brain anomalies; Cortical malformations; Prenatal insults

1. Introduction

The classic approach to the evaluation of the fetal brain by ultrasound is based on the transabdominal visualization of three different axial planes: the transventricular; the transthalamic; and the transcerebellar. Retrospective studies on the diagnosis of fetal CNS anomalies have shown that the use of these three planes help in the diagnosis of most, but not all, pathologies [1,2].

The major disadvantages of the use of these axial planes are poor visualization of the hemisphere proximal to the transducer and difficult depiction of midline brain structures, mainly the corpus callosum, the third ventricle, and the cerebellar vermis.

The use of a more comprehensive, multiplanar approach, in which coronal and sagittal planes are added to the classical axial planes, can overcome these limitations [3]. A transvaginal approach to fetuses in a vertex presentation or a transfundal approach to fetuses in a breech presentation are required in order to perform this detailed neurosonographic examination.

This article will describe our experience with normal and abnormal brain development during the third trimester of pregnancy, as depicted by multiplanar neurosonography.

2. Axial planes

Axial planes are routinely used for biometry assessment and screening for CNS anomalies (Fig. 1). The transventricular plane enables visualization of the posterior horn and atrium of the lateral ventricle and is used for the measurement of the lateral ventricular width. The cavum septi pellucidi is also depicted in this plane.

The transthalamic plane is used for the measurement of biparietal diameter and head circumference. The transcerebellar plane shows the cerebellum, vermis, and posterior fossa.

3. Coronal planes

In contrast with neonatal brain ultrasound, which is usually performed through the anterior fontanel, fetal brain ultrasound is performed through both the anterior and posterior

* Corresponding author.
E-mail address: malinger@nashim.net (G. Malinger).

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Fig. 1. Transabdominal axial planes at 25 weeks. (a) Transventricular plane shows the atrium and occipital horn of the distal lateral ventricle (1), the frontal horn (2), the cavum septi pellucidi (3), and the insula (4); (b) transthalamic plane shows the thalamus (1) and very thin third ventricle (2); (c) transcerebellar plane shows the cisterna magna (1), the cerebellum, and the vermis (2), middle cerebellar peduncles (3), and thalamus (4). Note the poor visualization of the proximal hemisphere.

fontanels and the sagittal suture. This results in the depiction of parallel coronal planes, rather than radial ones. During real time examination, a continuum of the brain is visualized. Four different coronal planes are described: transfrontal; transcaudate; transthalamic; and transcerebellar (Fig. 2).

The transfrontal coronal plane enables visualization of the frontal horns of the lateral ventricles, the interhemispheric, uninterrupted fissure, and the frontal cortex with the sulci and gyri at different stages of development according to the gestational age. The transcaudate coronal plane depicts the anterior portion of the corpus callosum. The cavum septi pellucidi is found inferior to the corpus callosum, with the lateral ventricles at each side. The caudate nuclei are well delineated from the cortex.

The transthalamic coronal plane shows the third ventricle, the foramina of Monro, and the insulae.

The last coronal plane is the transcerebellar, showing both occipital horns of the lateral ventricles (note that they may be slightly asymmetric), and the normal sulcation of the occipital lobes.

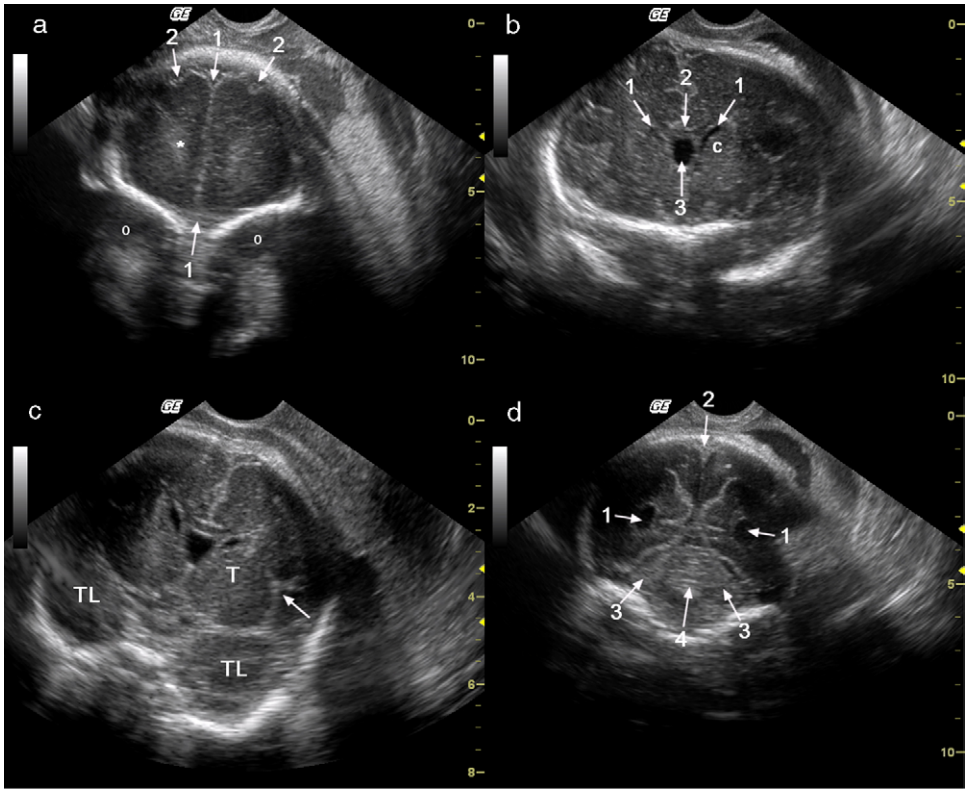

Fig. 2. Transvaginal coronal planes at 29 weeks. (a) Transfrontal plane slightly anterior to the frontal horns shows the hyperechogenic periventricular tissue (asterisk), the uninterrupted intrahemispheric fissure (1), the superior frontal sulci (2), and orbits (O); (b) transcaudate plane shows both frontal horns of the lateral ventricles (1), the corpus callosum (2), the cavum septi pellucidi (3), and the caudate (C; note the normal sulcation pattern); (c) transthalamic plane shows the insula (white arrow), the thalamus (T) and the temporal lobes (TL); (d) transcerebellar plane shows the occipital horns (1), the superior sagittal sinus (2), the cerebellar hemispheres (3), and the vermis (4).