Chapter 14

Cerebral Blood Flow Velocity Waveforms: Clinical Application
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This chapter reviews the clinical application of Doppler ultrasound velocimetry of the cerebral blood flow in the fetus. There are two main clinical applications of the fetal Doppler cerebral blood flow velocity waveforms:
1. Intrauterine growth restriction (IUGR) pregnancies
2. Diagnosis of fetal anemia

Which Is the Cerebral Vessel to Assess in the Fetus?

The circle of Willis is composed anteriorly of the anterior cerebral arteries (branches of the internal carotid artery that are interconnected by the anterior communicating artery) and posteriorly of the two posterior cerebral arteries (which are branches of the basilar artery and are interconnected on either side with the internal carotid artery by the posterior communicating artery). These two trunks and the middle cerebral artery (MCA), another branch of the internal carotid artery, supply the cerebral hemispheres on each side. These arteries have different flow velocity waveforms (FVWs) [1, 2] and, therefore, it is important to know which artery is being studied (Fig. 14.1). The MCA is the vessel of choice to assess the fetal cerebral circulation because it is easy to identify, has a high reproducibility, and provides in-

Fig. 14.1 A–H. Flow velocity waveforms of the arteries of the circle of Willis. The values indicate the pulsatility index. (From [2])
formation on the brain-sparing effect [3, 4]. Additionally, it can be studied easily with an angle of zero degrees between the ultrasound beam and the direction of blood flow and, therefore, information on the true velocity of the blood flow can be obtained [5]. Flow velocity waveforms of the middle cerebral artery change with advancing gestation (Fig. 14.2). The pulsatility index (PI) of the MCA is lower between 15 and 20 weeks’ gestation, whereas it has a higher value at the end of the second trimester and at the beginning of the third trimester (Fig. 14.3) [3]. The lower PI values early and late in gestation may be due to the increased metabolic requirements of the brain in these two periods of gestation [6].

Middle cerebral artery peak systolic velocity (MCA-PSV) increases exponentially with advancing gestation (Fig. 14.4) [5].

Cerebral Blood Flow Velocity Waveforms in the IUGR Fetus

Animal and human experiments have suggested that in the IUGR fetus there is an increase of blood flow to the brain [3, 4, 7–10]. This increase of blood flow can be evidenced by Doppler ultrasound of the MCA [3]. This effect is called the brain-sparing effect and is demonstrated by a lower value of the PI (Fig. 14.5). The brain-sparing effect appears to be a benign adaptive mechanism preventing severe brain damage [11]. Small-for-gestational-age (SGA) fetuses with brain-sparing effect less frequently developed intraventricular hemorrhage (IVH) than appropriate-for-gestational-age (AGA) premature fetuses with normal pulsatility index value of the MCA [12]. Following