Ultrasound in Med. & Biol., Vol. 31, No. 8, pp. 1023–1030, 2005

0301-5629/05/$–see front matter

ELSEVIER

doi:10.1016/j.ultrasmedbio.2005.04.009

● *Original Contribution*

FETAL HEMODYNAMICS EVALUATED BY DOPPLER VELOCIMETRY IN THE SECOND HALF OF PREGNANCY

ANTONIO GADELHA DA COSTA, FRANCISCO MAUAD FILHO, PATRICIA SPARA, EDUARDO BARRETO GADELHA, and PEDRO VIEIRA SANTANA NETTO

Department of Gynecology and Obstetrics, Faculty of Medicine of Ribeirão Preto, University of São Paulo, São Paulo, SP, Brazil

(*Received* 4 *January* 2005, *revised* 5 *April* 2005, *in final form* 14 *April* 2005)

Abstract—The objective of our study was to assess fetal hemodynamics by Doppler velocimetry during the second half of pregnancy. We carried out a longitudinal study on 33 normal fetuses between the 22nd and 38th weeks of gestation. Doppler velocimetry was performed in the aorta, suprarenal (SRA) and infrarenal (IRA) segments, middle cerebral artery (MCA) and umbilical artery (UA), on the basis of fetal peak systolic velocity (SV), end-diastolic velocity (DV) and resistance index (RI). We used a sample volume of 1 mm, a wall filter of 50 to 100 Hz, a 5° to 19° insonation angle in the MCA and UA, and below 60° in the SRA and IRA. Between the 22nd and 38th weeks of gestation, SV and DV increased in all fetal arteries ($p < 0.05$), but SV decreased in the UA from 52.5 to 46.2 cm/s between the 34th and 38th gestational weeks ($p < 0.05$). The RI was unchanged in the SRA and throughout most of the gestational weeks in the IRA ($p > 0.05$), but decreased from 0.69 to 0.56 in the UA ($p < 0.05$). In the MCA, it decreased from 0.85 to 0.75 between the 26th and 38th gestational weeks ($p < 0.05$). In conclusion, the volume of blood flow in the fetal organs necessary for their development is related to increased SV and DV and to decreased RI. The Doppler velocimetry measurements for normal fetuses could be compared with those for fetuses in high-risk pregnancies. (E-mail: iggadelha@ig.com.br) **© 2005 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Doppler velocimetry, Hemodynamics, Gestation, Ultrasonography.**

INTRODUCTION

The beginning of erythroblast movement in the embryo coincides with the beginning of the embryonic heart beats, occurring between five and six weeks of pregnancy. With the beginning of embryonic cardiac function, it is possible to observe the velocity of blood flow in the heart and in the longitudinal axis of the embryo, in aortic topography. The increase in blood flow and heartbeat velocity is related to embryo maturity (Ji et al. 2003).

One of the major challenges of modern science is the understanding of hemodynamic cardiovascular mechanisms and the physiological adaptation of fetal growth and development. During fetal development, there is an increase in fetal cardiac output and vascular compliance and a decrease in peripheral resistance that are responsible for the metabolic needs of the fetus and its growth (Phoon 2001).

Address correspondence to: Dr. A. Gadelha da Costa, Rua Antônio Joaquim Pequeno, 602, Apto. 202. Ed. Ana Cláudia - Bodocongó, Campina Grande, Paraíba 58109-085 Brazil. E-mail: iggadelha@ig.com.br

Some investigators have studied the fetal circulation, with emphasis on hemodynamic concepts. Chang et al. (2000) evaluated the arterial and venous circulation of human fetuses by Doppler velocimetry in the second half of gestation. Myers and Capper (2002) presented an artificial model for the description of the uteroplacental and fetal circulation. Ji et al. (2003) studied the embryonic circulation of rats using an ultrasonography apparatus with microscopic Doppler.

For characterization of fetal involvement and of hemodynamic adaptation in fetuses at risk, it is mandatory to recognize the fetal hemodynamic changes occurring during normal pregnancy (Chang et al. 2000).

Thus, the objective of this study was to assess the fetal hemodynamics by Doppler velocimetry using peak systolic velocity (SV), end-diastolic velocity (DV) and resistance index (RI) of the following fetal arteries: aorta, suprarenal (SRA) and infrarenal (IRA) segments, middle cerebral artery (MCA) and umbilical artery (UA), between the 22nd and 38th weeks of gestation.

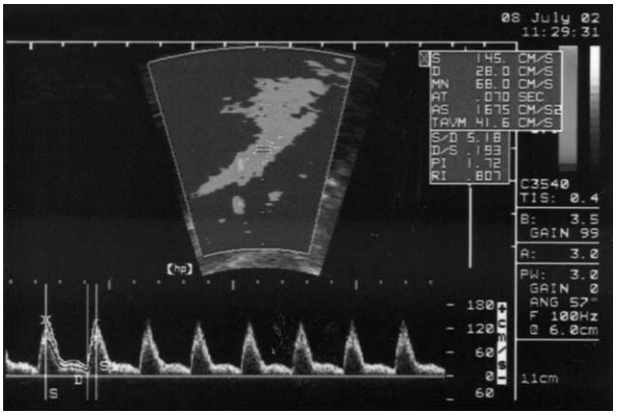

Fig. 1. Doppler velocimetry in the aorta (suprarenal segment), showing the wall filter, insonation angle, site of insonation and measurement of peak systolic velocity (S), end-diastolic velocity (D) and resistance index (RI).

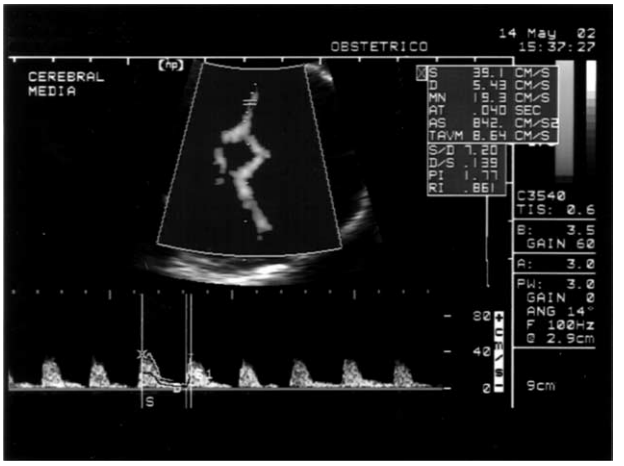

Fig. 3. Doppler velocimetry in the middle cerebral artery showing the wall filter, insonation angle, site of insonation and measurement of peak systolic velocity (S), end-diastolic velocity (D) and resistance index (RI).

MATERIALS AND METHODS

We conducted a longitudinal prospective study on 33 fetuses of pregnant women aged 15 to 41 years. The study was approved by the Research Ethics Committee of the University Hospital, Faculty of Medicine of Ribeirão Preto, University of São Paulo, Brazil, on September 3, 2001. All women had a singleton pregnancy and gestational ages ranged from 22 to 38 weeks, calculated based on the date of the last menstruation and/or by echographic evaluation of crown-rump length. Pregnant women with associated maternal diseases and/or pregnancy-related diseases, as well as smoking mothers and alcohol or drug users, were excluded. The fetuses did not have any malformation and showed adequate growth during pregnancy. All patients signed an informed consent form to participate in the study.

The first ultrasound (US) examination was performed between 8 and 12 weeks of gestation, to determine the gestational age based on crown-rump length. The Doppler velocimetry examinations were performed in each patient by a single observer (A. Gadelha da Costa) from 22 weeks on at four-week intervals (*i.e.*, at 22, 26, 30, 34 and 38 weeks of gestation). An Image Point 1800 ultrasonographic apparatus (Hewlett Packard; Houston, TX, USA) with a multifrequency transducer (5.0. 7.5 and 10 MHz) was used. The patient was positioned in dorsal decubitus in a semisitting position at an angle of 15 to 30^{o} between the subject and the examination table; thus, preventing compression of the vena cava

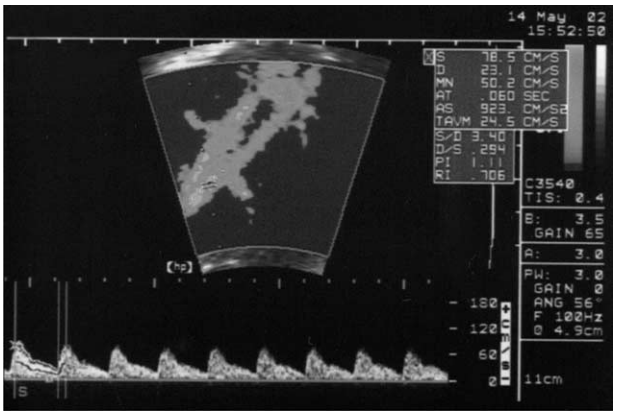

Fig. 2. Doppler velocimetry in the aorta (infrarenal segment), showing the wall filter, insonation angle, site of insonation and measurement of peak systolic velocity (S), end-diastolic velocity (D) and resistance index (RI).

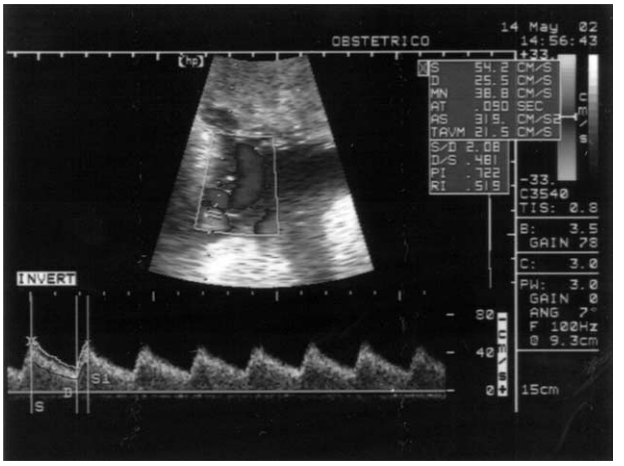

Fig. 4. Doppler velocimetry in the umbilical artery showing the wall filter, insonation angle, site of insonation and measurement of peak systolic velocity (S), end-diastolic velocity (D) and resistance index (RI).