

# Blood Gas Measurements in Fetal Umbilical Arterial and Venous Blood Obtained by Cordocentesis

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## **Abstract**

The blood gas measurements in fetal umbilical arterial and venous blood samples were performed. Blood samples for the study were obtained by cordocentesis between 24 and 36 weeks of uncomplicated gestation. The values of pH, pO<sub>2</sub>, and pCO<sub>2</sub> were measured. Blood sampling was performed under sonographic guidance. Totally 31 arterial and 29 venous blood samples were analysed. The correlation between pH of venous fetal blood, pO<sub>2</sub> of fetal arterial and venous blood with gestational age was observed.

## **Zusammenfassung**

Die Blutgasmessungen in arteriellem und venösem Nabelschnurblut wurden zwischen der 24. und 36. Woche bei unkomplizierten Schwangerschaften vorgenommen. pH-Wert, Sauerstoff und CO<sub>2</sub>-Sättigung wurden gemessen. Die Blutentnahme aus der Nabelschnur erfolgte unter sonographischer Kontrolle. Insgesamt wurden 31 arterielle und 29 venöse Blutproben analysiert. Dabei wurde eine Korrelation zwischen pH-Wert des venösen Blutes und der Sauerstoffsättigung des arteriellen und venösen Blutes und der Dauer der Schwangerschaft beobachtet.

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In recent years the introduction of the technique of cordocentesis performed under direct sonographic guidance has permitted blood sampling<sup>3,5</sup> from the umbilical arteries and vein for determination of fetal acid-base and respiratory blood gas values at steady state. Also other techniques such as Doppler velocimetry have been introduced to predict changes in fetal blood gas measurements<sup>9</sup>. In normal pregnancy the placenta serves as the respiratory system for the fetus, takes part in the excretion of hydrogen ion's and thus maintains fetal acid-base and blood gas homeostasis<sup>1</sup>. Various pregnancy complications such as PIH and renal disease may lead to placental circulatory insufficiency, restriction of placental transport and risk of fetal death. Determination of fetal acid-base and blood gas values in these cases allows direct assessment of fetal condition and thus contributes to making appropriate for clinical management<sup>2,4</sup>. Abnormal values can only be defined on the basis of reference values obtained in uncomplicated pregnancies.<sup>6,7</sup> The aim of the present study was to obtain reference values of pH, pO<sub>2</sub>, pCO<sub>2</sub> in fetal blood samples obtained by cordocentesis between 24 and 36 weeks of uncomplicated gestation.

### Material and Methods

The study was performed in the I Department of Obstetrics and Gynecology, University School of Medicine in Warsaw between 1991 and 1993. Acid base status was estimated in 23 fetuses diagnosed because of Rh-incompatibility and found to be antigen negative. In 6 cases only arterial blood was sampled, in 4 cases only venous blood and in 13 cases both arterial and venous blood. The detection of the vessel (artery or vein) was based on the direction of blood flow (to or from the placenta). The following 12 samples were obtained from the fetuses with detected renal<sup>8</sup> and CNS defects<sup>4</sup>. In cases where in puncture line 2 vessels were observed 2 blood samples: arterial and venous were obtained. Totally the analysed material consisted of 31 arterial and 29 venous blood samples. All blood samples were aspirated under sonographic guidance using sector transducers of Aloka SSD 280 or Bruel & Kjaer Units. Umbilical vessel was punctured with thin needle with outer diameter of 0.7–0.9 mm, 1.0 ml of fetal blood was aspirated into 2 ml syringe with heparin. Directly after aspiration pH and blood gases were determined with the use of an IL 1304 analyser.

### Results

Results are demonstrated in Figs. 1–6. pH of fetal arterial blood was between 7.26 and 7.39. The mean value in the whole group was 7.33 with a standard deviation of 0.029. There was no correlation between pH values and gestational age. However the pH values in venous blood were between 7.27–7.41 and the mean value for the whole group was 7.35, SD = 0.033. The pH values in venous blood show a significant correlation with gestational age ( $p < 0.001$ ). The difference between pH of the venous and arterial blood increases during pregnancy. The values of pO<sub>2</sub> decrease with gestational age both in arterial and venous blood. pO<sub>2</sub> values in arterial blood were between 24.2–52.1 mmHg. The mean value for

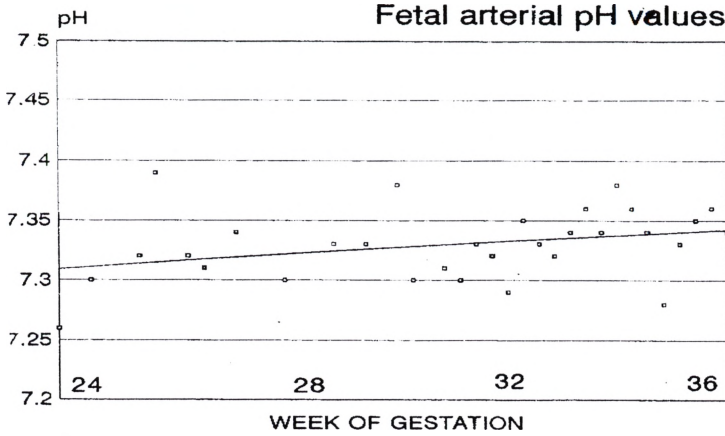


Fig. 1.

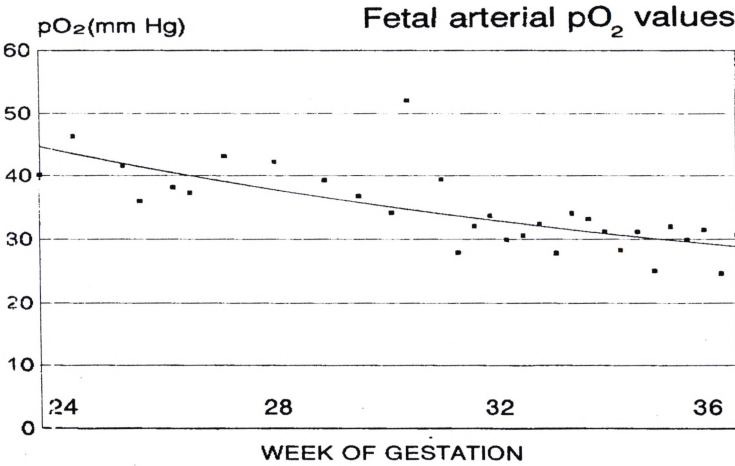


Fig. 2.

the whole period of observation was 34.6 mmHg, SD = 6.14. Venous pO<sub>2</sub> was between 30.0–56.4 mmHg, the mean value was 40.42 mmHg, SD = 7.26 ( $p < 0.001$ ). An evident dependence between pO<sub>2</sub> in venous blood and gestational age was determined. In reverse but less significant a correlation was observed in relation to pCO<sub>2</sub> in fetal blood. The values of pCO<sub>2</sub> in arterial blood were between 34.0–53.1 mmHg, the mean value for the whole group was 43.44 mmHg, SD = 4.23. The values of pCO<sub>2</sub> in venous blood were characterised by great dispersion between 29.8–44.0 mmHg. The mean value was 38.47 mmHg, SD = 3.66. The lack of correlation between pCO<sub>2</sub> and gestational age is represented by  $p = 0.1$ .

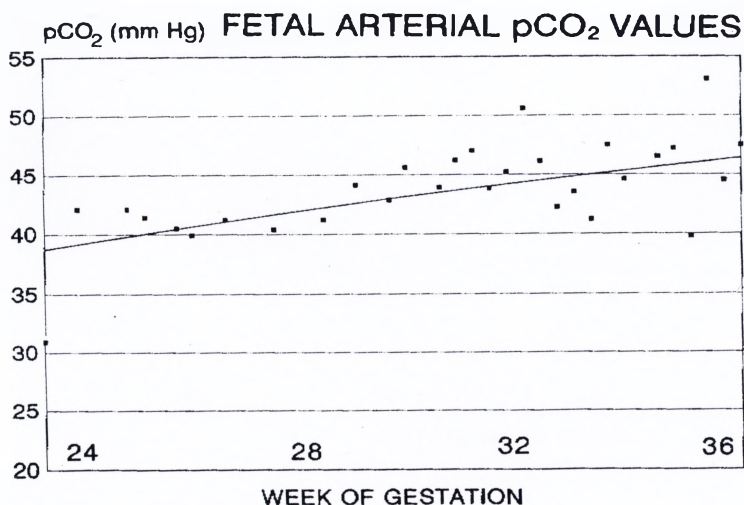


Fig. 3.

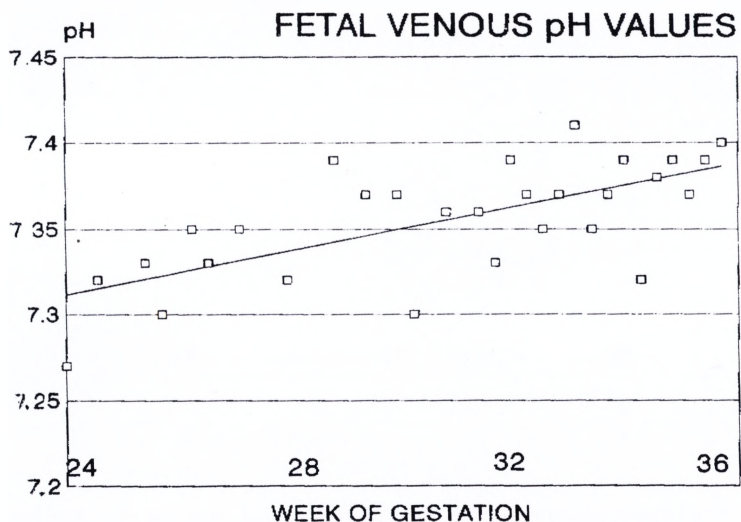


Fig. 4.

### Discussion

The stability of the acid-base status parameters is one of the main homeostatic systems of the human being. The sufficiency of this system is the resultant of the respiratory, metabolic and excretory functions of the organism. The system that regulates the acid-base balance is characterised by the great adaptation possibilities. Only severe changes in efficiency of the particular system may lead to marked gasometric changes. The evaluation of blood pH, oxygen saturation or base deficit are routine examinations in adult patients in routine inpatient prac-

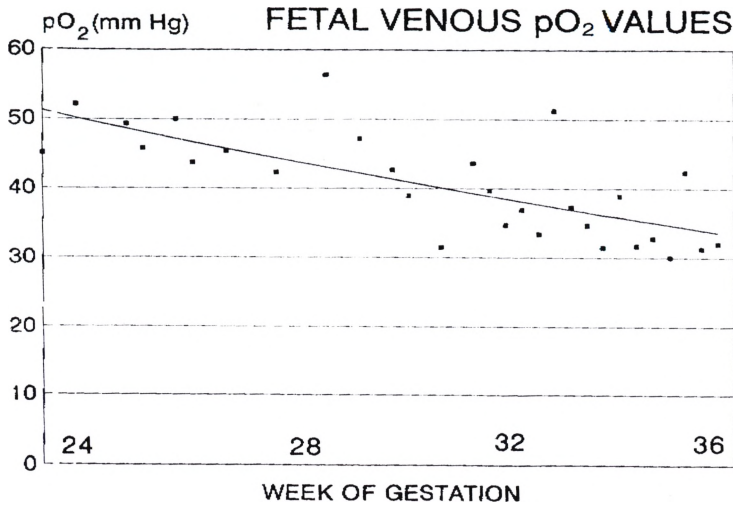


Fig. 5.

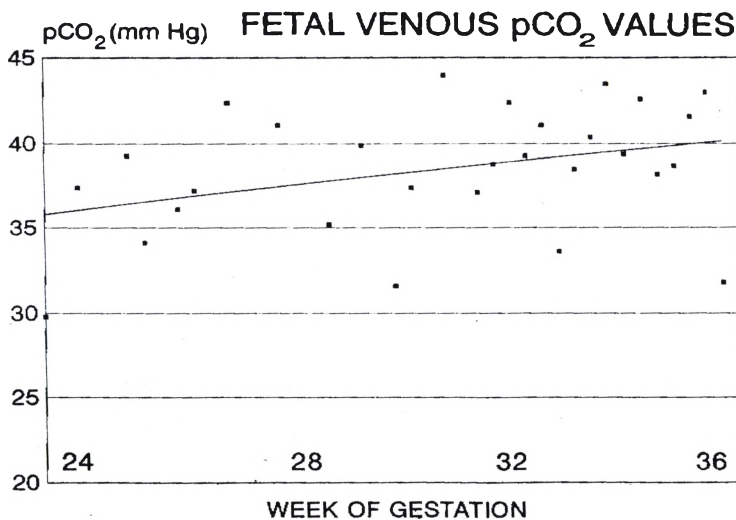


Fig. 6.

tice. Also in obstetrics the evaluation of the acid-base balance is performed in order to establish the actual condition of the fetus during labour. In spite of many controversions the parameters of the capillary blood obtained from the scalp are presumed to be the most accurate indices of the fetal conditions. The sensitivity of other biophysical methods is estimated by comparison with gasometric results. Required condition for capillary blood sampling (ruptured membranes, cervix opening) limit the use of this method to the period of labour. The performance of this examination exclude the continuation of pregnancy. Until recently, all



efforts to examine fetal acid-base and respiratory blood gas homeostasis during pregnancy were based on the evaluation of the amniotic fluid. Gasometric changes of the amniotic fluid are non-characteristic and occur with considerable delay to real fetal distress. In relation to that fact this method acquired little clinical acceptance. The introduction of cordocentesis gave the possibility to access into fetomaternal and obtain blood samples for gasometric analysis. Of course norms for particular gasometric parameters differ from those accepted for adults. As many other parameters they change during fetal growth. As mentioned before the aim of this study was to determine the range of selected parameters. It revealed important changes in pH values in fetal venous blood with increasing difference between pH of the venous and arterial blood during pregnancy. It may indicate the increase of metabolic processes of the growing fetus. Parallely the sufficient placenta is able to excrete excessive number of hydrogen ions.

### Conclusions

1. The pH of venous fetal blood systematically raises from 7.3 in 24 week of pregnancy to 7.4 in the 36 week of pregnancy. Significant correlation with gestational age was determined. 2. During pregnancy decrease in  $pO_2$  both in arterial and venous blood is observed. 3. The values of  $pCO_2$  in arterial blood slightly increases during pregnancy. The similar but less significant correlation is observed in venous blood.

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