19. Taylor ES. Editorial comments. Obstet Gynecol Surv 1983; 38:96.
20. Rizos N, Doran TA, Miskin M, Benzie RJ, Ford JA. Natural history of placenta previa ascertained by diagnostic ultrasound. Am J Obstet Gynecol 1979;133:287-91.
21. Chapman MG, Furness ET, Jones WR, Sheat HJ. Significance of the ultrasound location of placental site in early pregnancy. Br J Obstet Gynaecol 1979;86:846-8.
22. Meyer MB, Jonas BS, Tonascia JA. Perinatal events associated wtih maternal smoking during pregnancy. Am J Epidemiol 1976;103:464-76.
23. Naeye RL. Abruptio placentae and placenta previa: frequency, perinatal mortality, and cigarette smoking. Obstet Gynecol 1980;55:701-4.
24. Williams MA, Mittendorf R, Lieberman E, Monson RR, Schoenbaum SC, Genest DR. Cigarette smoking during pregnancy in relation to placenta previa. Am J Obstet Gynecol 1991;165:28-32.
25. Buck GM, Michalek AM, Kramer AA, Batt RE. Labor and delivery events and risk of sudden infant death syndrome. Am J Epidemiol 1991;133:900-6.

Placental and fetal Doppler velocimetry in pregnancies complicated by maternal diabetes mellitus

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OBJECTIVE: Our purpose was to investigate placental and fetal circulation in pregnancies complicated by maternal diabetes mellitus and to relate any changes to fetal blood pH, Po_2, and hematocrit.
STUDY DESIGN: Doppler measurements of both uterine arteries, one umbilical artery, the fetal descending thoracic aorta, and one fetal middle cerebral artery were performed in 65 well-controlled diabetic pregnancies in a cross-sectional study at the Harris Birthright Research Centre for Fetal Medicine, London. In 41 cases cordocentesis was also performed for the measurement of umbilical venous blood pH, Po_2, and hematocrit.
RESULTS: The mean umbilical venous blood pH was significantly lower and the hematocrit significantly higher than the appropriate normal mean for gestation. However, the Doppler indices of the placental and fetal circulations were essentially normal, except in some of the cases complicated by preeclampsia or intrauterine growth retardation.
CONCLUSIONS: Maternal diabetes mellitus is not associated with abnormalities in Doppler indexes of the placental or fetal circulations. (Am J Obstet Gynecol 1993;168:645-52.)

Key words: Diabetes mellitus, cordocentesis, Doppler blood flow, blood gases

Doppler studies of the placental and fetal circulations have improved the understanding of the cardiovascular adjustments in different fetal-maternal conditions. In intrauterine growth retardation (IUGR) caused by uteroplacental insufficiency, impedance to flow in the uteroplacental and fetoplacental circulations is increased.[1] Furthermore, there is an association between fetal hypoxemia and acidemia and redistribution in the fetal circulation in favor of the brain and at the expense of the viscera.[1, 2]

In red blood cell isoimmunization, the fetus is subjected to varying degrees of anemic hypoxia (decreased oxygen content caused by anemia but usually normal partial pressure of gases).[3] Impedance to flow in the placental and fetal circulations is normal; however, these fetuses have a hyperdynamic circulation, as demonstrated by increased blood velocity in the fetal descending thoracic aorta and middle cerebral artery in proportion to the degree of fetal anemia.[4]

The aim of the current study was to investigate a third model of fetal-maternal disease, that of maternal diabetes mellitus, where some fetuses are polycythemic and acidemic, in the presence of a normal Po_2.[5] Previ-

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ous Doppler studies in such pregnancies have been confined to the placental circulation (uterine and umbilical arteries) and have provided conflicting results.[6-11]

Patient and methods

During a 24-month period color flow mapping and pulsed Doppler velocimetry of the placental and fetal circulations were performed at 18 to 24, 27 to 33, and 35 to 40 weeks' gestation in 65 pregnant women attending our antenatal clinic for pregnancies complicated by maternal diabetes mellitus. In the patients with established diabetes ($n = 44$) Doppler studies were performed at all three gestational ranges, except in eight patients who were delivered at <35 weeks. In patients with gestational diabetes ($n = 21$) measurements were taken only in the last two gestational ranges, because in our center screening for, and therefore the diagnosis of, gestational diabetes is made at 28 weeks. In 41 cases umbilical venous blood gases were measured in blood obtained by cordocentesis, which was performed up to 24 hours before elective delivery. Before giving their written consent, all patients were counseled that the procedure was for research purposes and that the results would not give any direct benefit to their current pregnancy. The study was approved by our hospital ethics committee.

In the group with established diabetes all patients were treated with insulin, and, according to the White classification, 12 belonged to group B, 21 to group C, five to group D, two to group F, and four to group F/R[12]; in the gestational diabetes group 17 were treated with insulin and four with diet alone. The patients were managed by a combined team of diabetologists and obstetricians.

Doppler examinations were performed with the patient in the supine position with left lateral tilt. Color flow mapping, to identify the vessels, and pulsed-wave velocimetry (color Doppler Aloka echocamera SSD-680, with 3.5 MHz curvilinear transducer, Aloka, Tokyo), were used to obtain flow velocity waveforms from (1) both uterine arteries at the level where they cross the corresponding external iliac artery, (2) one umbilical artery from a free loop of the cord, (3) the fetal descending thoracic aorta at a position just above the diaphragm, and (4) one of the middle cerebral arteries from a portion of these vessels near the circle of Willis.

In all Doppler studies the angle of insonation of the vessels was <45 degrees and the high-pass filter was set at 100 Hz.[13] Care was taken not to exert undue pressure on the fetal head because this alters the flow velocity waveforms from the middle cerebral artery.[14] Furthermore, examinations of the fetal vessels were performed in the absence of fetal body and respiratory movements.[15] Measurements were obtained from four consecutive flow velocity waveforms and averaged. By means of the built-in spectrum analyzer, the resistance index was measured in both uterine arteries, and the higher of the values was used for further analysis. From the flow velocity waveforms of the umbilical artery, middle cerebral artery, and fetal descending thoracic aorta the pulsatility index was measured. The intensity-weighted, time-averaged mean velocity was also calculated for the fetal descending thoracic aorta and middle cerebral artery from the frequency shift, obtained by spectral analysis (Doptek spectrum analyser, Doptek, Chichester, England), and the angle of insonation by the Doppler formula.

Cordocentesis was carried out immediately after Doppler assessment without fetal paralysis or maternal sedation, and all procedures were uncomplicated.[16] Fetal blood was collected into heparinized syringes (350 μl) for blood gas analysis (Radiometer ABL330, Copenhagen) and for measurement of whole-blood glucose (YSI 23A, Yellow Springs Instruments, Yellow Springs, Ohio). Fetal blood was also collected into tubes containing ethylenediaminetetraacetic acid (300 μl) for measurement of hematocrit (Coulter Stacker-plus, Coulter, Luton, England). Kleihauer testing confirmed that all samples contained only fetal blood. At the time of cordocentesis a maternal venous blood sample was taken from the antecubital fossa for the measurement of whole-blood glucose and glycosylated hemoglobin percentage by electroimmunodiffusion (Corning scanner, Corning, Halstead, England). In the 24 cases that did not have cordocentesis the maternal glycosylated hemoglobin percentage in the last week of pregnancy was used in any subsequent statistical analysis.

The Doppler results, umbilical venous blood pH, Po_2, and hematocrit, and maternal glycosylated hemoglobin percentage were expressed as the number of standard deviations by which individual values differed from the appropriate normal mean for gestation (Δ-value).[1, 2, 5, 16-18] Subsequently, Student t test was applied to determine whether the mean of the measured parameters differed significantly from that of the appropriate reference range. Regression analysis was applied to determine the significance of any associations between the umbilical venous blood pH and Po_2 and the maternal and fetal blood glucose concentration and between the last Doppler measurements and maternal glycosylated hemoglobin percentage, umbilical venous blood pH, Po_2, and hematocrit.

Results

The 65 diabetic pregnancies were subdivided into three groups. Group 1 included 54 patients with no pregnancy complications delivered at 36 to 40 weeks' gestation and two with unexplained spontaneous premature delivery at 32 to 34 weeks. In all cases the infants were healthy. All birth weights were above the

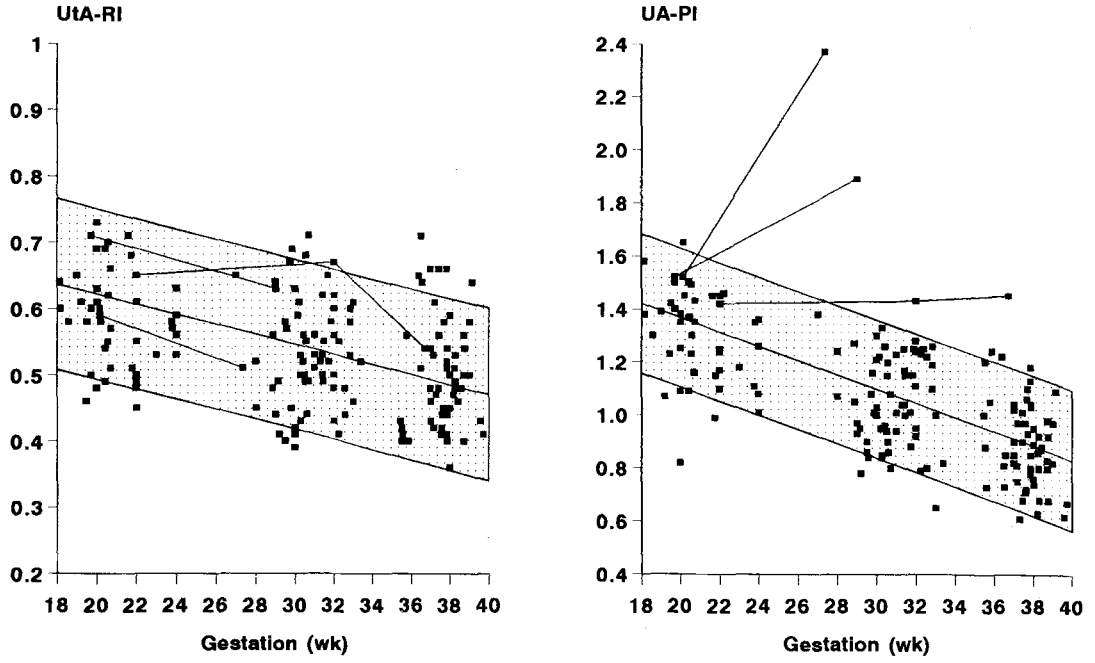

Fig. 1. Uterine artery resistance index *(UtA-RI)* and umbilical artery pulsatility index *(UA-PI)* plotted on appropriate reference range (mean, 5th and 95th percentiles). Serial measurements of two patients in group 3 and one from group 2 with blood flow redistribution are illustrated by *joined points.*

5th percentile and in 11 cases the birth weight was above the 95th percentile for gestation. In group 2 there were six patients with diabetic nephropathy, and the infants were delivered at 27 to 36 weeks because of worsening maternal proteinuria, hypertension, and renal function[19]; in four cases the birth weight was appropriate for gestation, and in the other two cases the birth weight was <5th percentile. Group 3 comprised three patients; in one case elective delivery was undertaken at 29 weeks' gestation because of ultrasonographic evidence of IUGR and suboptimal fetal heart rate pattern; in the second and third cases preeclampsia developed in the late third trimester and delivery was undertaken at 35 to 36 weeks' gestation. Two of the three infants were growth retarded (<5th percentile).

In 42 cases the neonatal period was uncomplicated. In 14 cases the neonatal period was complicated by hypoglycemia requiring admission to our neonatal intensive care unit. In addition, a further nine neonates were admitted to the neonatal intensive care unit because of prematurity and respiratory distress syndrome. The respiratory distress syndrome was of sufficient severity to require ventilation in six patients. Permanent sequelae were confined to one infant in whom bronchopulmonary dysplasia developed.

The Doppler results of the three groups of diabetic patients are shown in Figs. 1 to 3. In group 1, with a total of 145 Doppler examinations, there were no cases with consistently abnormal results either in the placental or fetal circulations. Thus high (>95th percentile) uterine artery resistance index or umbilical artery pulsatility index values were observed in 11 cases on only one occasion. Similarly, occasional values of middle cerebral artery or descending thoracic aorta mean velocity or pulsatility index were outside the normal ranges, but no patients had evidence of redistribution in the fetal circulation (high fetal descending thoracic aorta pulsatility index, high middle cerebral artery mean velocity, low fetal descending thoracic aorta mean velocity, and low middle cerebral artery pulsatility index).

In group 2 in five of six cases all the Doppler measurements were within the appropriate reference ranges. In the sixth case, where the fetus was growth retarded, all the Doppler measurements were initially normal, but in the measurements immediately before delivery the umbilical artery pulsatility index was above the 95th percentile and there was evidence of blood flow redistribution in favor of the brain and at the expense of the viscera. Details on group 2 cases were reported previously.[19]

In one of the three cases in group 3 all the Doppler measurements were normal. In the other two patients of group 3, the uterine artery resistance index was within the normal range, but the umbilical artery and fetal descending thoracic aorta pulsatility index values increased progressively with gestation from within the normal range to above the 95th percentile. Further-

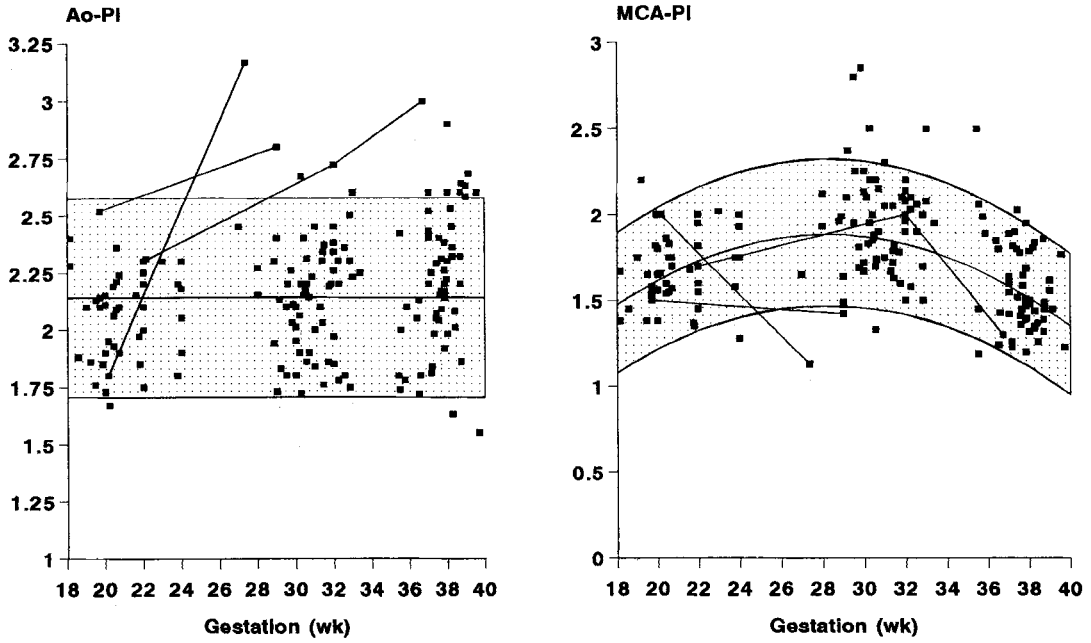

Fig. 2. Pulsatility index of descending thoracic aorta *(Ao-PI)* and middle cerebral artery *(MCA-PI)* plotted on appropriate reference range (mean, 5th and 95th percentiles). Serial measurements for two patients from group 3 and one from group 2 with blood flow redistribution are illustrated by *joined points.*

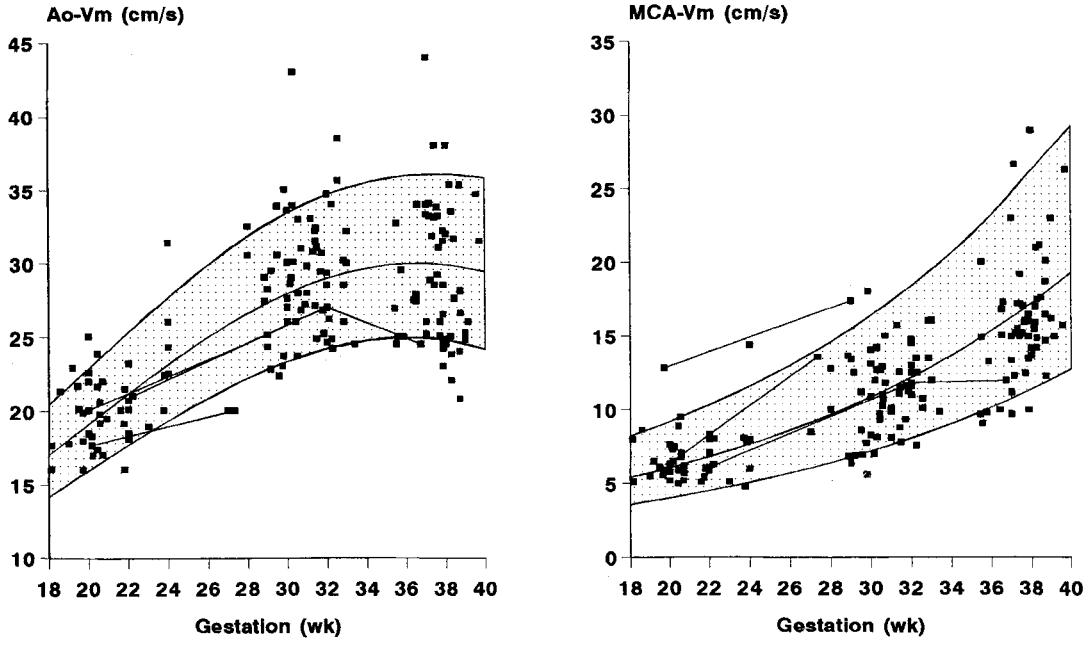

Fig. 3. Mean velocity of descending thoracic aorta *(Ao-Vm)* and middle cerebral artery *(MCA-Vm)* plotted on appropriate reference range (mean, 5th and 95th percentiles). Serial measurements for two patients from group 3 and one from group 2 with blood flow redistribution are illustrated by *joined points.*

more, in one case the middle cerebral artery mean velocity was consistently above the 95th percentile and the pulsatility index fell to below the 5th percentile. In the other case the descending thoracic aorta mean velocity progressively decreased to below the 5th percentile, and middle cerebral artery pulsatility index and mean velocity remained within the normal ranges.

The mean maternal glycosylated percentage (8.69%,

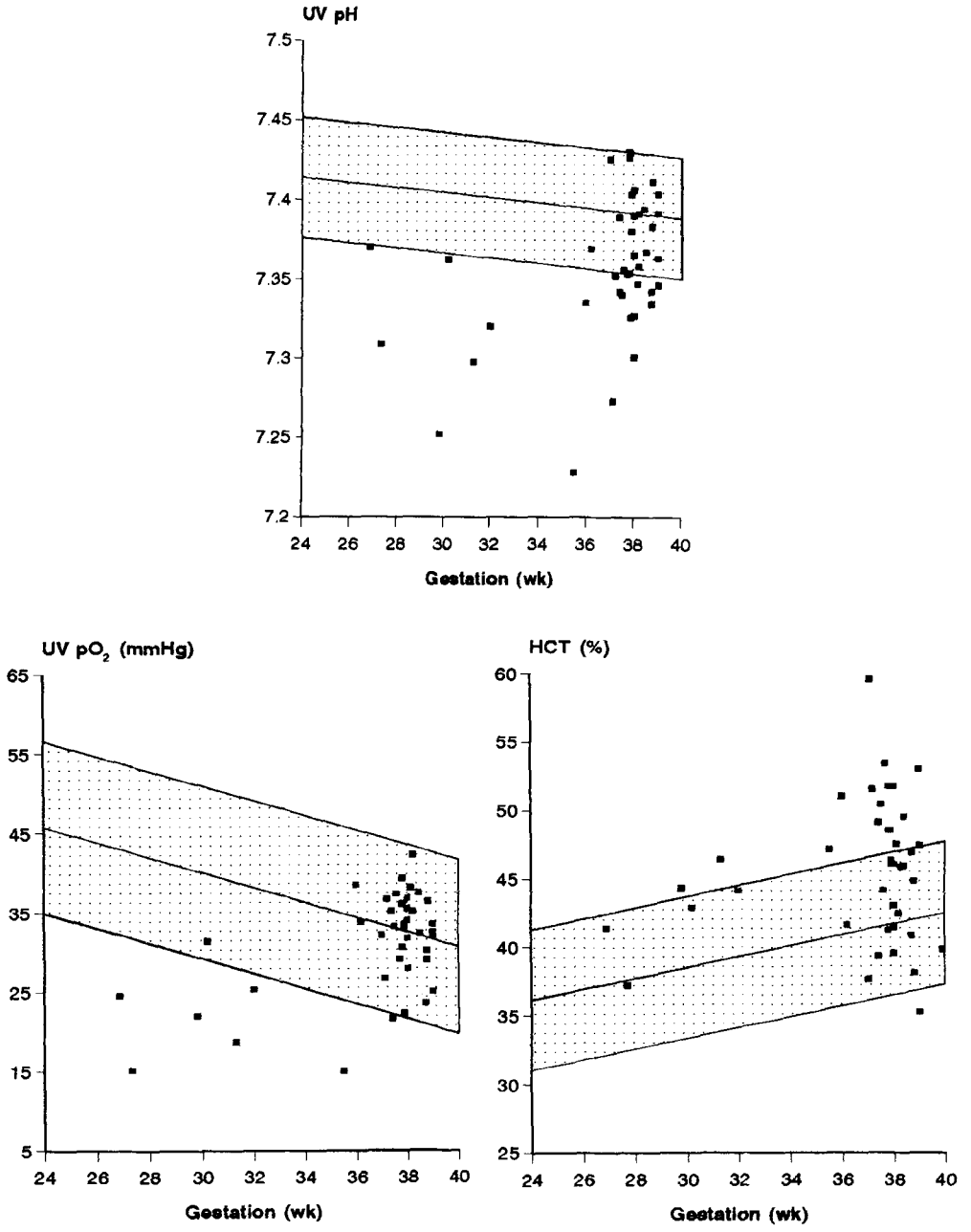

Fig. 4. Umbilical venous *(UV)* blood pH, Po_2, and hematocrit *(HCT)* for 41 cases that underwent cordocentesis plotted on appropriate reference range (mean, 5th and 95th percentiles).

range 5.5% to 12.7%) of the diabetic pregnancies was significantly higher than the appropriate normal mean for gestation (normal mean 6.9%, range 5.7 to 8.1; mean difference: SD 2.864, SE 0.273, $t = 10.49$, $p < 0.0001$).

In the 41 pregnancies that underwent cordocentesis, the mean fetal hematocrit was significantly higher and the mean umbilical venous blood pH significantly lower than the appropriate normal mean for gestation (mean difference: SD 1.091, SE 0.252, $t = 4.33$, $p < 0.0001$ and mean difference: SD − 1.460, SE 0.297, $t = -4.92$, $p < 0.0001$, respectively) (Fig. 4). The mean umbilical venous blood Po_2 was not significantly lower than the normal mean for gestation (mean difference: SD 0.405, SE 0.205, $t = -1.98$, not significant).

There was a significant association between fetal and maternal blood glucose concentration at cordocentesis ($r = 0.971$, $p < 0.0001$). There were also significant associations between both maternal and fetal blood glucose concentration and Δ-values of umbilical venous blood pH ($r = -0.693$, $p < 0.0001$ and $r = -0.664$,

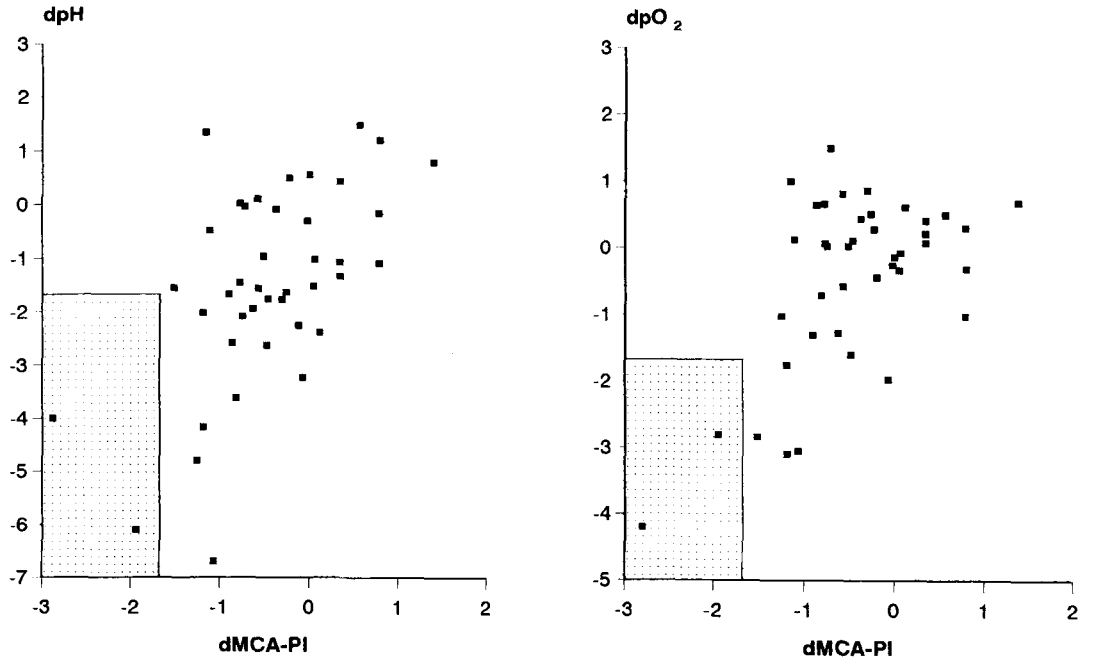

Fig. 5. Relationship between Δ-values for middle cerebral artery pulsatility index *(dMCA-PI)* and umbilical venous blood pH *(dpH left)* and Po_2 *(dpO$_2$ right). Shaded area,* Umbilical venous blood pH, Po_2, and middle cerebral artery pulsatility index <5th percentile for gestation.

Table I. Correlation coefficients derived by regression analysis for relationship between Δ-values of Doppler parameters and Δ-values of umbilical venous blood pH, Po_2, and hematocrit at cordocentesis (n = 41) and maternal glycosylated hemoglobin (n = 65)

	Δ-Value					
Δ-Value	*Uterine artery resistance index*	*Umbilical artery pulsatility index*	*Aorta pulsatility index*	*Aorta mean velocity*	*Middle cerebral artery pulsatility index*	*Middle cerebral artery mean velocity*
pH	0.191	−0.402*	−0.211	0.015	0.463*	−0.356†
Po_2	0.086	−0.544‡	−0.247	0.062	0.456*	−0.421*
Hematocrit	−0.054	0.232	−0.007	−0.026	−0.134	−0.115
Maternal glycosylated hemoglobin	0.076	−0.011	0.270	−0.049	−0.002	−0.190

*$p < 0.01$.
†$p < 0.05$.
‡$p < 0.001$.

$p < 0.0001$, respectively) and Po_2 ($r = -0.551$, $p < 0.001$ and $r = -0.575$, $p < 0.001$, respectively). The interrelationships of Δ-values of the Doppler parameters to Δ-values of pH, Po_2, hematocrit, and maternal glycosylated hemoglobin are shown in Table I. Although there was a significant association between the Δ-values of middle cerebral artery pulsatility index and those of pH and Po_2, low middle cerebral artery pulsatility index (<5th percentile or −1.69 SD) was of limited clinical value in identifying the hypoxemic or acidemic fetuses (Fig. 5).

Comment

The data from this study demonstrate that in pregnancies complicated by maternal diabetes mellitus the uteroplacental and fetoplacental circulations are essentially normal, except in those cases complicated by preeclampsia or IUGR. Our findings are consistent with those of three previous studies that demonstrated that diabetes mellitus as such is not associated with increased impedance to flow in the umbilical artery.[8, 9, 11] However, Bracero et al.[6, 7, 10] reported that impedance to flow is increased in both the umbilical and uterine

arteries. One possible explanation for this discrepancy is that their study population included patients with poorer diabetic control. This may also explain their finding of a significant association between impedance to flow and the degree of maternal hyperglycemia.

The fetal acidemia in uncomplicated diabetic pregnancies is probably metabolic in origin, and the tendency for fetal acidemia and hypoxemia in those pregnancies complicated by diabetic nephropathy may also either be a consequence of poor glycemic control or of altered placental transfer.[5, 19, 20] Although in this study there were significant associations between Doppler parameters and umbilical venous blood pH and Po_2, because the Doppler measurements were essentially normal in those without preeclampsia or IUGR, they did not provide a clinically useful prediction of the degree of metabolic derangement in the fetus.

In IUGR caused by uteroplacental insufficiency fetal acidemia is associated with Doppler evidence of fetal blood flow redistribution.[1, 2] The absence of redistribution in many of the acidemic fetuses in this study suggests that this hemodynamic alteration occurs only with the severe or chronic fetal acidemia observed in placental insufficiency. In the pregnancies of the current study the degree of fetal acidemia was relatively mild. Furthermore, because fetal blood pH is significantly associated with maternal blood glucose concentration, it is possible that the degree of fetal acidemia is liable to acute fluctuations related to short-term maternal glycemic control.[5] It is also possible that the fetal blood flow redistribution observed in IUGR is a consequence of metabolic derangements that do not accompany the fetal acidemia of pregnancies complicated by maternal diabetes mellitus.[21-23]

In anemic fetuses of pregnancies complicated by red blood cell isoimmunization, the increased blood flow velocity is thought to be caused by decreased blood viscosity with consequent increased venous return and cardiac output.[4] Although in fetuses of diabetic mothers blood viscosity is increased as a consequence of polycythemia,[24] in our study group the fetal descending thoracic aorta and middle cerebral artery mean velocity were normal. Furthermore, there was no significant association between the degree of fetal polycythemia and these Doppler indices. This finding suggests that the increase in hematocrit observed in this study may not have been sufficient to adversely affect blood viscosity.[25]

This study has demonstrated that in pregnancies of women with diabetes mellitus, in spite of fetal acidemia and polycythemia the results of Doppler studies of the placental and fetal circulations are essentially normal except in those complicated by IUGR or preeclampsia. The extent to which poor diabetic control is associated with alteration in the fetal circulation remains to be determined.

REFERENCES

1. Bilardo CM, Nicolaides KH, Campbell S. Doppler measurements of fetal and uteroplacental circulations: relationship with umbilical venous blood gases measured at cordocentesis. Am J Obstet Gynecol 1990;162:115-20.
2. Vyas S, Nicolaides KH, Bower S, Campbell S. Middle cerebral artery flow velocity waveforms in fetal hypoxaemia. Br J Obstet Gynaecol 1990;97:797-802.
3. Nicolaides KH. Studies on fetal physiology and pathophysiology in rhesus disease. Semin Perinatol 1989;13:328-37.
4. Nicolaides KH, Kaminopetros P. The clinical value of waveforms from the descending thoracic aorta: red cell iso-immunization. In: Pearce JM, ed. Doppler ultrasound in perinatal medicine. Oxford: Oxford University Press, 1992:244-57.
5. Salvesen DR, Brudenell JM, Nicolaides KH. Fetal polycythemia and thrombocytopenia in pregnancies complicated by maternal diabetes mellitus. Am J Obstet Gynecol 1992;166:1287-92.
6. Bracero LA, Schulman H, Fleischer A, Farmakides G, Rochelson B. Umbilical artery velocimetry in diabetes and pregnancy. Obstet Gynecol 1986;68:654-8.
7. Bracero LA, Jovanovic L, Rochelson B, Baum W, Farmakides G. Significance of umbilical and uterine artery velocimetry in the well controlled pregnant diabetic. J Reprod Med 1989;34:273-6.
8. Landon MB, Gabbe SG, Bruner JP, Ludmir J. Doppler umbilical velocimetry in pregnancy complicated by insulin-dependent diabetes mellitus. Obstet Gynecol 1989;73: 961-5.
9. Dicker D, Goldman JA, Yeshaya A, Peleg D. Umbilical artery velocimetry in insulin dependent diabetes mellitus (IDDM) pregnancies. J Perinat Med 1990;18:391-5.
10. Bracero LA, Schulman H. Doppler studies of the uteroplacental circulation in pregnancies complicated by diabetes. Ultrasound Obstet Gynecol 1991;1:391-4.
11. Johnson FD, Steel JM, Haddad NG, Hoskins PR, Greer IA, Chambers S. Doppler umbilical artery flow velocity waveform in diabetic pregnancy. Br J Obstet Gynaecol 1992; 99:135-40.
12. White P. Classification of obstetric diabetes. Am J Obstet Gynecol 1978;130:228-30.
13. Burns PN, Jaffe CC. Quantitative flow measurements with Doppler ultrasound: techniques, accuracy and limitations. Radiol Clin North Am 1985;23:641-57.
14. Vyas S, Campbell S, Bower S, Nicolaides KH. Maternal abdominal pressure alters fetal cerebral blood flow. Br J Obstet Gynaecol 1990;97:740-7.
15. Marsal K, Lindblad A, Lingman G, Eik-Nes SH. Blood flow in the descending aorta: intrinsic factors affecting fetal bloodflow, i.e. fetal breathing movements and cardiac arrhythmia. Ultrasound Med Biol 1984;10:339-48.
16. Worth R, Potter JM, Drury J, Cullen DR. Glycosylated haemoglobin in normal pregnancy: a longitudinal study with two independent methods. Diabetologia 1985;28: 76-9.
17. Nicolaides KH, Economides DL, Soothill PW. Blood gases, pH, and lactate in appropriate and small-for-gestational-age fetuses. Am J Obstet Gynecol 1989;161:996-1001.
18. Yudkin PL, Aboualfa M, Eyre JA, Redman CWG, Wilkinson AR. New birth weight and head circumference centiles for gestational ages 24-42 weeks. Early Hum Dev 1987; 15:45-52.
19. Salvesen DR, Higueras MT, Brudenell JM, Drury PL, Nicolaides KH. Doppler velocimetry and fetal heart rate studies in nephropathic diabetics. Am J Obstet Gynecol 1992;167:1297-303.

20. Bradley R, Brudenell JM, Nicolaides KH. Fetal acidosis and hyperlacticaemia diagnosed by cordocentesis in pregnancies complicated by maternal diabetes mellitus. Diabetic Med 1991;8:464-8.
21. Economides DL, Nicolaides KH, Linton EA, Parry LA, Chard T. Plasma cortisol and ACTH in small-for-gestational-age fetuses. Fetal Ther 1988;3:158-64.
22. Economides DL, Crook D, Nicolaides KH. Investigation of hypertriglyceridemia in small-for-gestational-age fetuses. Fetal Ther 1988;3:165-72.
23. Economides KH, Nicolaides KH, Gahl W, Bernardini I, Evans M. Plasma amino acids in appropriate- and small-for-gestational-age fetuses. Am J Obstet Gynecol 1989; 161:1219-27.
24. Foley ME, Collins R, Stronge JM, Drury MI, MacDonald D. Blood viscosity in umbilical cord blood from babies of diabetic mothers. J Obstet Gynecol 1981;2:93-6.
25. Ramamurthy RS, Brans YW. Neonatal polycythemia. I. Criteria for diagnosis and treatment. Pediatrics 1981;68: 168-74.

Characterization of large-conductance, calcium-activated potassium channels from human myometrium

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OBJECTIVES: The purpose of our study was to detect and characterize potassium channels in the plasma membrane of smooth muscle cells from human myometrium.
STUDY DESIGN: Plasma membrane vesicles were incorporated into lipid bilayers to record single potassium channel activity.
RESULTS: We predominantly found a "maxi" calcium-activated potassium channel (261 picosiemens). This channel was calcium (micromoles per liter range) and voltage sensitive, highly selective for K^+ over Na^+ and Cs^+, and was sensitive to external tetraethylammonium (dissociation constant $\approx$ 220 μmol/L) and charybdotoxin (dissociation constant $\approx$ 23 nmol/L). External apamin and 4-aminopyridine had no effect on this channel. Another type of potassium channel that was less frequently observed was also identified. It had a smaller conductance (142 picosiemens) and it seemed to be calcium independent (up to 50 nmol/L).
CONCLUSION: Human myometrium possesses abundant "maxi" calcium-activated potassium channels. This channel shares common characteristics with other "maxi" calcium-activated potassium channels, including calcium and voltage gating, high conductance and selectivity, and channel pharmacologic profile. (Am J Obstet Gynecol 1993;168:652-60.)

Key words: Reconstitution, lipid bilayer, uterus, K^+ channels, human beings

The uterus is the central organ of reproduction and gestation. It is known that potassium currents play an important role in smooth muscle excitability.[1, 2] However, in uterine smooth muscle there are only a few reports about these currents.[3-5] The particular type of channels involved in potassium currents has not been well clarified. There are some different results about the involvement of calcium-activated potassium (K_{Ca}) channels in myometrium potassium currents. Recently, Kihira et al.[6] identified a 204 picosiemens conductance K_{Ca} channel in rat myometrium. Previous studies in our laboratory demonstrated that potassium currents from rat myometrium are caused in part by the activity of K_{Ca} channels.[3, 7] Consistent with these results, studies in human myometrium have provided evidence that potassium currents in this tissue may be partially caused by the activity of these channels.[8] On the other hand, the evidence of Kao et al.[9] did not suggest the presence of this calcium-activated potassium current in pregnant rat myometrium.[9] Because the level of expression of different potassium channels may differ between spe-

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