Title: THE BIOCHEMICAL PROFILE OF A WELL-OXYGENATED HUMAN FETUS

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Data from either animal studies or vaginally born neonates have been used to build the biochemical profile of unborn human fetuses. Labor and delivery cause increased H^+ and lactate (L) concentrations in the mother and fetus and therefore such data may not reflect the true fetal biochemical status. We have developed a metabolic profile using neonatal data obtained at the time of elective cesarean delivery.

Methods. The protocol was approved by the local review board. Patients (n=90) gave informed consent. All were healthy with single gestation. Following 1200 ml Ringer's lactate infusion, epidural anesthesia was induced to T_4 level using 18±5 ml lidocaine 1.5% with 1:200,000 epinephrine. The uterus was displaced 15° to the left. Mothers inhaled 50% O_2. Any systolic pressure < 100 torr was promptly treated with ephedrine. At delivery, maternal arterial (MA) pH, PO_2 and PCO_2 maternal venous (MV antecubital vein) and fetal umbilical venous (UV) and arterial (UA) blood glucose (G), lactate (L), pyruvate (P), PO_2, PCO_2 and pH were measured. Excess lactate (XL) was calculated using Huckabee's equation and base excess (BE) using Severinghaus's formula. HCO_3^- was calculated from the Henderson-Hasselbach equation. Results were expressed as mean ± 1 SE. Maternal and fetal measurements were correlated with regression analysis and the differences between measurements were asssessed using t test.

Results. No baby had an Apgar score of < 7 at 1 minute or < 9 at 5 minutes. Eighteen patients required 9± 1 mg ephedrine. MV blood L, P (Fig1), G, L/P and XL correlated with both UV and UA values (Table). MV L did not differ from UV or UA L. G and P were significantly greater ($p<0.0005$) and XL and L/P ratio were significantly smaller ($p<0.001$) in the mother than in the fetus. UA L was significantly greater ($p<0.05$) than UV L. Both UV and UA HCO_3^- and BE were significantly greater than MA ($p<0.0001$). Hypotension promptly treated with ephedrine did not increase fetal UA L (1.9±0.1 mMol/L in the ephedrine treated group and 1.8±0.1 in the untreated group). No significant correlation was noted between H^+ and L (Fig 2), P, XL or L/P ratio in UV or UA blood. MA, UV and UA PO_2 were 238±7, 32±1 and 20±1 torr, respectively. The corresponding PCO_2 were 29±0.5, 40±1 and 48±1 torr.

Discussion. Maternal and fetal L and P levels showed correlation probably because 1) both mother and fetus received L and P from the placenta and/or 3) their tissues had a similar pattern of glycolysis. Increased fetal L/P ratio and XL were due to decreased P and not due to increased L. Increased maternal P was secondary to anxiety induced G elevation. Because UA L was greater than UV L, it is unlikely that the human fetus (in contrast to the animal fetus[1]) utilizes placental L as a nutrient. However, the fetus extracts G from the umbilical circulation. Because fetal BE was greater than maternal BE, fixed acid transfer from the mother to fetus may not be an important factor in initiating the "double Bohr shift" which facilitates transplacental O_2 transfer. The necessary changes in H^+ seem to be due to CO_2 transfer alone. Our data also suggest that L production and H^+ accumulation are two unrelated phenomena in normoxic fetuses, and that contrary to previous reports,[2] epidural anesthesia does not cause fetal lactic acidosis.

Table

	MV(MA)	UV	UA	r 1	r 2
G	104 (4)	88 (3)	77 (3)	0.7	0.5
L	1.48 (0.1)	1.45 (0.1)	1.53 (0.1)	0.5	0.6
P	0.1 (0.01)	0.08 (0.01)	0.08 (0.01)	0.5	0.5
L/P	17 (1)	22 (1)	21 (1)	0.3	0.5
XL	0.5 (0.1)	0.7 (0.1)	0.7 (0.1)	0.29	0.6
pH	7.42 (0.01)	7.35 (0.01)	7.3 (0.01)	0.6	0.3
HCO_3^-	18 (0.4)	21.4 (0.4)	23 (0.4)	0.06	0.06
BE	-6 (0.3)	-3.5 (0.3)	-2.8 (0.3)	0.6	0.08

G, L, XL (mMol/L) and L/P ratio were measured in MV, and maternal pH, HCO_3^- and BE in MA. r_1 - correlation coefficient for MV or MA vs UV, and r_2 vs UA. All r's were significant at 1% level (two-tailed) except for r1 and r2 for HCO_3^- and r2 for BE.

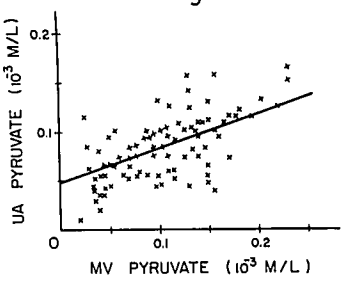

FIG 1

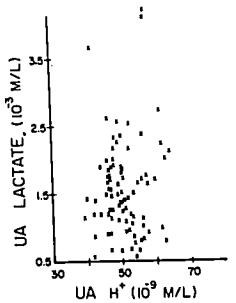

FIG 2

Legend, Fig 1: y=0.32x + 0.049, r=0.51, $p<0.0005$
Fig 2: y=0.015x + 0.79, r=0.11, p for slope and r NS

References: 1) Sparks JW, et al. J Clin Invest 70:179-192, 1982.
2) Antoine C, Young BK. Am J Obstet Gynecol 142:55-59, 1982.