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CORRESPONDENCE

Correlation between fetal Doppler indices and neonatal acid–base status at birth in healthy appropriate for gestational age term fetuses

Nicola Fratelli[1] · Valentina Benedetta Brunelli[1] · Vera Gerosa[1] · Enrico Sartori[1] · Andrea Lojacono[1] · Federico Prefumo[1]

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Dear Sir,

Recent evidence published in this journal [1] and by our group [2] does not entirely clarify whether fetal cerebroplacental ratio (CPR) measured shortly before labour could identify fetuses likely to require obstetric intervention for intrapartum fetal compromise. In fact, the use of Cesarean section for fetal distress and composite adverse neonatal outcome as surrogate markers of prelabor fetal hypoxia does not allow to understand if CPR is a good predictor of antepartum fetal oxygenation, or if events in labor play a greater role than prelabor fetal oxygenation in the development of intrapartum fetal distress [1–4]. Aiming to clarify this issue, we performed a prospective observational cohort study in healthy, appropriate for gestational age (AGA) term fetuses to evaluate the correlation between maternal/fetal Doppler waveforms and umbilical cord acid–base analysis, the most objective assessment of the acid–base status at birth. We included 48 singleton pregnancies with scheduled Cesarean section at term (indications were: 10, breech presentation; 26, previous Cesarean section; 8, Cesarean delivery on maternal request; 3, maternal medical indication; 1, suspected fetal macrosomia). Fetuses with estimated birthweight or fetal abdominal circumference ≤ 10th percentile, fetal abnormality or aneuploidy were excluded. Umbilical artery pulsatility index (UA PI), middle cerebral artery PI (MCA PI), CPR, normalized umbilical vein blood flow (nUV) [3, 4] and mean uterine artery PI (UtA PI) were assessed on the same day of the scheduled Cesarean section. Multiples of the median (MoM) were calculated to adjust for gestational age. The acid–base status at birth was assessed by arterial and venous umbilical cord blood samples and its correlation with Doppler measurements assessed with Pearson's correlation coefficients. Population characteristics are shown in Table 1. Correlation measurements are shown in Table 2. A significant negative correlation was found between UtA PI, umbilical artery pH ($r = -0.3704$, $p = 0.001$) and umbilical vein pH ($r = -0.3751$, $p = 0.009$) and between the UA PI, arterial pH ($r = -0.3194$, $p = 0.03$) and venous pH ($r = -0.3263$, $p = 0.02$). Birthweight, MCA PI, CPR and nUVBF did not correlate with acid–base status at birth. Our data suggest that CPR provides a poor assessment of fetal oxygenation in healthy AGA fetuses delivered at term by Cesarean section. We speculate that events in labor play a much greater role than prelabor fetal oxygenation in the development of fetal distress in labor, and that acid–base status at birth might reflect placental perfusion. Further studies are needed to evaluate the performance of maternal and fetal Doppler parameters for the prediction of fetal hypoxemia in term AGA fetuses.

✉ Federico Prefumo
federico.prefumo@unibs.it

[1] Division of Obstetrics and Gynecology, Department of Clinical and Experimental Sciences, ASST Spedali Civili and University of Brescia, P.le Spedali Civili 1, 25123 Brescia, Italy

Table 1 Population characteristics

Maternal characteristics	
Age (years)	37 (34.1–39.4)
Body mass index (kg/m^2)	27 (24–30)
Nulliparous	23%
White ethnicity	83%
Gestational age (weeks)	39 (38^{+5}–39^{+1})
Neonatal characteristics	
Birthweight (g)	3295 (3120–3550)
Birthweight percentile	57 (41–85)
Male sex	46%
Umbilical arterial blood	
pH	7.29 (7.27–7.32)
Base excess (mmol/l)	1.15 (2.05–0.2)
Lactate (mmol/l)	1.8 (1.675–2.3)
pCO_2 (mmHg)	57 (52–62)
pO_2 (mmHg)	12 (9–16)
O_2 saturation (%)	11 (6–18.25)
Hemoglobin (g/dl)	14.6 (13.6–15.7)
Hematocrit (%)	43 (40–46.25)
HCO_3^- (mmol/l)	27.2 (25.7–28.175)
Umbilical venous blood	
pH	7.35 (7.31–7.37)
Base excess (mmol/l)	1.7 (2.95–0.6)
Lactate (mmol/l)	1.6 (1.475–1.9)
pCO_2 (mmHg)	43.5 (39–48.25)
pO_2 (mmHg)	27 (20–30.5)
O_2 saturation (%)	47 (26.75–56)
Hemoglobin (g/dl)	15 (13.8–15.7)
Hematocrit (%)	44 (40.75–46.25)
HCO_3^- (mmol/l)	23.7 (23.025–24.925)
Doppler parameters	
UA PI MoM	0.820 (0.751–0.915)
UtA PI MoM	1.026 (0.892–1.255)
MCA PI MoM	1.213 (1.072–1.384)
CPR MoM	1.073 (0.957–1.292)
nUVBF (ml/min/kg)	62,329 (46,369–71,421)

UA umbilical artery, *UtA* uterine arteries, *MCA* middle cerebral artery, *PI* pulsatility index, *CPR* cerebro-placental ratio, *MoM* multiples of the median, *nUVBF* normalized umbilical vein blood flow

Table 2 Correlation between acid–base and Doppler measurements with their correlation (correlation coefficient *r* and *p* value)

	UA MoM	UtA MoM	MCA MoM	CPR MoM	nUVBF	Birth weight (SD)
Umbilical venous blood						
pH						
r	−0.3263	−0.3751	−0.1378	0.009	0.1271	−0.2692
p	0.0236*	0.0086*	0.3501	0.9516	0.3895	0.0643
pO_2						
r	−0.1142	−0.0594	−0.2539	−0.1966	−0.1318	0.0546
p	0.4396	0.6883	0.0817	0.1804	0.372	0.7126
pCO_2						
r	0.1718	0.3501	0.1224	0.0494	−0.0319	0.2668
p	0.2428	0.0147*	0.4072	0.7386	0.8298	0.0668
Lactate						
r	0.4416	0.3718	0.1907	−0.0342	−0.0509	0.2062
p	0.0017*	0.0093*	0.1941	0.8175	0.7314	0.1597
Base excess						
r	−0.0969	0.0526	−0.189	−0.1153	0.101	0.0772
p	0.5123	0.7228	0.1981	0.435	0.4947	0.6021
O_2 saturation						
r	−0.1252	−0.1616	−0.2158	−0.167	−0.0878	−0.0590
p	0.3964	0.2725	0.1408	0.2566	0.5528	0.6905
Umbilical arterial blood						
pH						
r	−0.3194	−0.3704	−0.0696	0.0682	0.1086	−0.2657
p	0.0269*	0.0096*	0.6384	0.6451	0.4624	0.0680
pO_2						
r	−0.0677	−0.0771	−0.2475	−0.1998	0.0142	−0.1214
p	0.6475	0.6023	0.0899	0.1732	0.9235	0.4110
pCO_2						
r	0.2226	0.3881	0.0101	−0.0742	−0.1097	0.2076
p	0.1283	0.0064*	0.9457	0.6161	0.4578	0.1567
Lactate						
r	0.0551	0.0967	−0.0666	−0.097	−0.1181	0.1604
p	0.7098	0.5133	0.6531	0.5117	0.4241	0.2762
Base excess						
r	−0.4692	−0.198	−0.0997	0.1268	0.1665	−0.0677
p	0.0008*	0.1773	0.5	0.3906	0.258	0.6476
O_2 saturation						
r	−0.1024	−0.1478	−0.1063	−0.0676	0.0765	−0.1097
p	0.4884	0.3161	0.4721	0.6482	0.605	0.4578

UA umbilical artery, *UtA* uterine arteries, *MCA* middle cerebral artery, *PI* pulsatility index, *CPR* cerebro-placental ratio, *MoM* multiples of the median, *nUVBF* normalized umbilical vein blood flow, *SD* standard deviation

*p value < 0.05

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to declare.

References

1. Stumpfe FM, Kehl S, Pretscher J, Baier F, Bayer CM, Schwenke E, Schneider MO, Mayr A, Schild RL, Schmid M, Beckmann MW, Faschingbauer F (2019) Correlation of short-term variation and Doppler parameters with adverse perinatal outcome in low-risk fetuses at term. Arch Gynecol Obstet 299(2):411–420
2. Fratelli N, Mazzoni G, Maggi C, Gerosa V, Lojacono A, Prefumo F (2018) Cerebroplacental ratio before induction of labour in normally grown fetuses at term and intrapartum fetal compromise. Eur J Obstet Gynecol Reprod Biol 227:78–80
3. Bligh LN, Alsolai AA, Greer RM, Kumar S (2018) Prelabor screening for intrapartum fetal compromise in low-risk pregnancies at term: cerebroplacental ratio and placental growth factor. Ultrasound Obstet Gynecol 52(6):750–756
4. Fiolna M, Kostiv V, Anthoulakis C, Akolekar R, Nicolaides KH (2019) Prediction of adverse perinatal outcome by cerebroplacental ratio in women undergoing induction of labor. Ultrasound Obstet Gynecol 53(4):473–480