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PLASMA VISCOSITY IN UMBILICAL CORD: ITS RELATIONSHIPS WITH THE PHYSIOLOGICAL WEIGHT LOSS IN NEWBORNS

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ABSTRACT. The physiological weight loss in the newborn has been related to the elimination and the low ingestion of liquids in the first days of life. The degree of weight loss, generally less than 10% of the birth weight, is related to the resolution in higher or lesser degree of neonatal edema and an adequate administration of liquids to the newborn. The following study was done to test the hypothesis that the physiological weight loss in the newborn could be related to homeostatic situations before delivery, which would determine the fluid balance in the first few days of life. We analyzed the relationship between plasma viscosity and blood density of cord blood with weight loss in the first 48 hours of life. Twenty-six healthy newborns of gestational ages between 259 and 296 days (278±8, mean±SD) were studied. The following parameters were determined in the umbilical artery and vein: haematocrit, blood density, plasma viscosity and osmolality Blood gas parameters were determined using a blood gas analyzer. We determined the weight of the newborn at birth and after 48 hours. We did not find significant differences between the arterial and venous blood densities, with a density in the umbilical artery of 1.05±0.01 g/ml and 1.06±0.03 g/ml in the umbilical vein. The weight loss in the first 48 hours in the newborn was 151±80.8 g, with a birth weight of 3325±414 g. Our results suggest that decrease of body liquid volume in the fetus is accompanied by an increase in plasma viscosity which could produce a decrease of the neonatal diuresis with less physiological weight loss in the newborn after delivery. This event is related to a decrease of fetal plasma bicarbonate.

Key Words: Blood density. Umbilical cord. Newborn. Plasma viscosity. Blood rheology. Weight.

INTRODUCTION

Physiological weight loss in the newborn is related to the minimal ingestion of liquids in the first days of life and with the cession of physiological edema. During the neonatal period the capacity of the kidney to concentrate urine is limited and the renal blood flow is decreased which has an influence on the fluid balance in the first days of life (1,2). Another important factor is the amount of blood transferred to the fetus from the placenta which greatly affects total body fluid. The kind of delivery also influences body fluid volume (3).

It is demonstrated by the higher degree of physiological edema and weight loss in neonates from a caesarean section. The physiological weight loss must be less than 10% of the birth weight. It increases in situations where imperceptible fluid losses are increased such as hyperbilirubinemia treated with phototherapy.

The following study was done to test the hypothesis that the physiological weight loss in the newborn could be related to homeostatic situations before delivery, which would determine the fluid balance in the first few days of life. We analyzed the relationship between plasma viscosity and blood density with weight loss in the first 48 hours of life.

MATERIAL AND METHODS

Patients. We studied 26 full-term newborns, with gestational ages between 259 and 296 days (278±8), from not instrumental delivery and with Apgar scores more than 8 at 5 minutes. We examined the state of the placenta (presence or lack of infarcts) and the volume and aspect of amniotic fluid at birth. The macroscopic examination of the placentas showed presence of infarcts in 8 cases. All newborns with oligohydramnios, polyhydramnios or meconium stained amniotic fluid were excluded. Informed consent was obtained from the parents of all newborns included in the study. We collected somatometric data (weight, height and cephalic perimeter) after delivery in the same circumstances to every newborn. We performed a systematic examination after six hours, during this period the newborns with pathological changes (distress, malformation, congenital cardiac diseases, sepsis, jaundice) were excluded from the study. After 48 hours we performed the second clinical examination and we collected somatometric data again. The ambient temperature was constant in all cases and all newborns received maternal lactation with bottle propping (25 ml).

Analytical methods. The umbilical cord was clamped in all cases in the 1st minute after delivery, at 3 cm of cutaneous insertion. The samples were collected by venipuncture of the umbilical artery and vein in the placental fetal side, so as to prevent contamination with Wharton's jelly, which could alter the values of plasma viscosity. We used disposable syringes containing (10 µg/ml) 10% EDTA as an anticoagulant. The hematocrit was determined, using an electronic cell counter (Coulter), blood density by the exact relation weight/volume of blood, plasma viscosity by a Harkness capillary viscosimeter (Coulter, series 8052), osmolality with a digital osmometer and pO_2, pCO_2, pH, sO_2 and bicarbonate in a blood gas analyzer. The Shapiro and Wilk's tests was used, followed by correlation and regression analysis and t-test.

RESULTS

As shown in TABLE I, significant differences were not found between arterial and venous umbilical blood densities in newborns ($t=1.26$; $p=ns$) with an umbilical artery value of 1.05±0.01

g/ml and an umbilical vein value of 1.06±0.03 g/ml.
The plasma viscosity and the osmolality in the umbilical artery and vein were not different significantly in accordance with other authors (4,5). Mean weight loss in the first 48 hours was 151±81 g for a birth weight of 3325±414 g. Mean height in the newborn was 50.5±1.7 cm.

TABLE I
Values observed of term neonates (n=26). (***) p<0.001 statistical significance; ns statistically not significant (mean ± SD).

	Umbilical artery	Umbilical vein	
Plasma viscosity (mPa.s)	0.95 ± 0.07	0.98 ± 0.11	ns
Osmolality (mOsm./Kg)	287.0 ± 13.6	290.0 ± 16.1	ns
Blood density (g/ml)	1.05 ± 0.01	1.06 ± 0.03	ns
pH	7.22 ± 0.06	7.29 ± 0.08	***
$NaHCO_3$ (mEq/l)	20.8 ± 3.2	20.7 ± 2.39	ns
pCO_2 (mmHg)	48.0 ± 9.8	41.6 ± 8.1	***
pO_2 (mmHg)	18.7 ± 5.5	27.6 ± 5.2	***
O_2 saturation (%)	29.2 ± 19.1	45.7 ± 16.0	***

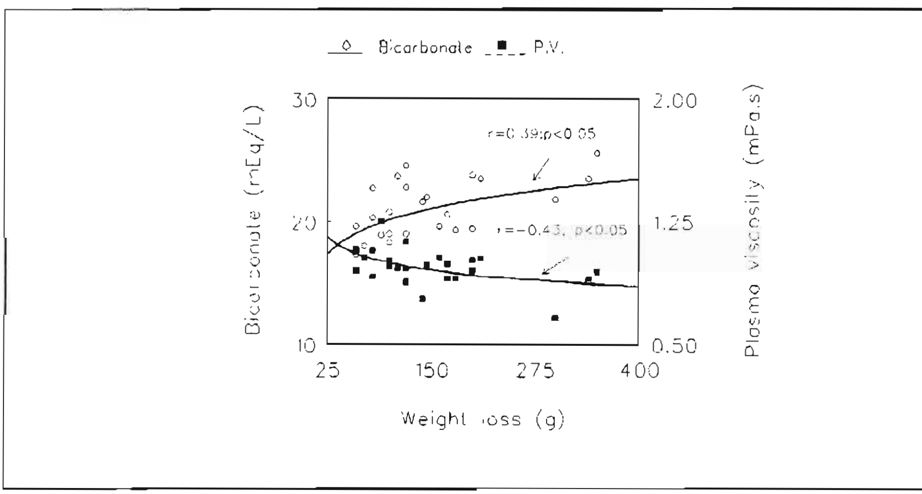

FIG. 1
Significant relationship between plasma viscosity and blood bicarbonate with physiological weight loss of the newborn.

TABLE II shows the correlation coefficients between weight loss in the first 48 hours of life and the rest of variables. We found significant correlation coefficients between weight loss and plasma viscosity (r=-0.43; p<0.05) and between blood bicarbonate in umbilical vein and physiological weight loss in the newborns (r=0.39; p<0.05). The correlation and regression study shows the existence of a strong association between birth weight and weight at 48 hours of life (r=0.98; p<0.001). The coefficients of variation for the density was 0.03.

TABLE II

Correlation ("r" of Pearson) to weight loss of term newborns during first 48 hours of life and the variables studied in the umbilical vein. (*) $p<0.05$ statistical significance; (ns) non-signficance statistical.

Plasma viscosity	r= -0.43	(*)	pO_2	r= 0.14	(ns)
Blood density	r= -0.18	(ns)	pCO_2	r= 0.12	(ns)
Osmolality	r= 0.22	(ns)	$NaHCO_3$	r= 0.39	(*)
pH	r= 0.11	(ns)	sO_2	r= 0.14	(ns)
Hematocrit	r= 0.21	(ns)			

DISCUSSION

Physiological weight loss in newborns has been related to the inability of the newborn to concentrate urine maximally (1). The plasma osmolality in newborns at full-term is about 282 mOsm/kg; the osmolality of the urine at birth after deprivation of water ranges from 500 to 700 mOsm/kg compared to 1200 mOsm/kg in an adult. Many factors may contribute to the low ability of renal concentration of urine in the neonate. The most important (2,6) are: 1) A reduced rate of glomerular filtration, 2) A short Henle's loop in the cortical glomerulus and 3) Low nitrogenated metabolism which cause a low concentration of nitrogen in the serum and a low renal medullar osmolality. Other situations which may contribute to antidiuresis in the newborn are derived from a renal insensitivity to ADH or a decrease in ADH secretion (5). These authors also justified neonatal antidiuresis by the immaturity of the medullar adenosine monophosphate ciclic (AMPc) and the high E_2-prostaglandin levels and circulating prostacyclin in the neonate (2,6,7). Changes in oxygen tension have been shown to alter vascular tone of the umbilical artery (8). In physiological conditions, nitric oxide participates in regulation of the glomerular microcirculation modulating afferent arteriolar tone and relaxing the mesangium (9,10).

Blood density is proportional to hematocrit and plasma protein concentration, but may also be influenced by other plasma solutes. The relationships between the blood density and other haemorrheological factors has already been described (11,12) with particular reference to the aggregability but until now the relationship between plasma viscosity and weight loss in the neonate has not yet been described.

In the study of feto-placental unit we may separate the information of the umbilical vascular system (13). The umbilical vein brings oxygenated blood from the placenta to the fetal circulation; it is an excellent model to study the placental performance. The umbilical artery brings deoxygenated blood from the fetal circulation to the placenta; therefore, it is an excellent model to study the fetus.

During the neonatal period more than one neurohormonal system regulates the blood volume (2). The movement of sodium, bicarbonate and fluid from pregnant to fetus through the placenta is performed by a mechanism of "diffusion", the modifications of the uterus-placental flow by the effect of estrogens, adrenergic hormones and eucosanoids may influence in the final intravascular volume. The different renal reabsorption of bicarbonate and water, the diuresis and the physiological weight loss in the newborn after the delivery may be influenced by the final intravascular volume of the newborn before the birth (14, 15, 16). On basis of our findings, the fetus with high concentrations of bicarbonate shows an increased weight loss during neonatal period, it is due to a body liquid volume higher. The diuresis in theses newborns may be increased after delivery and therefore the weight loss is also increased. We think our findings are in accordance with the values published by Brace (17), who refers a decrease of the blood volume in accute fetal hypoxia. This event is accompanied with a decrease in concentrations of bicarbonate.

Regeneration of bicarbonate and reabsorption of water occurs at the same time as the excretion of non-volatile acids in the distal segments of the nephrone. It is important in the adult but it is not in the newborn. Other mechanisms related to hydrogen ion secretion and regeneration of bicarbonate in the kidney are: the concentration of sodium in the distal tubules of the nephron, hypopotassemia and acidosis (18, 19, 20). The regeneration mechanisms of bicarbonate and acidification of urine are not fully developed in the newborn. This may be deduced from the inability to acidify the urine below pH 6 in cases of systemic acidosis in the newborn (15,16). The fetus is not capable of producing enough bicarbonate so that the plasma concentrations of bicarbonate in the fetus depend on the "facilited diffusion" from the mother to the fetus through the placenta. Therefore, the fetal blood volume after delivery depends on the state of utero-placental circulation directly. In the placentas with a good vascularizacion the transport of bicarbonate from the mother to the fetus is optimum and the comsuption of bicarbonate by the fetus is scanty. On the contrary, the placentas with infarcts or with decrease of the uterus-placental blood flow have major difficulties to carry out a good transport of bicarbonate from the mother to the fetus, moreover these fetus may suffer hypoxia so that the consumption of bicarbonate would be increased. These events, in differents degrees, would explain a maximum fetal blood volume in pregnancies with good uterus-placental circulation and a decrease of the fetal blood volume in pregnancies with decreased uterus-placental circulation

Thereby, we think the relationship between weight loss and plasma viscosity in the umbilical vein shows a placental regulation of the fetal hidrosaline metabolism. On the contrary the relationship between plasma viscosity and the weight loss indicates an increase in body liquid with a greater weight loss in the newborn when the plasma viscosity in the fetus is decreased.

Our results suggest that decrease of body liquid volume in the fetus is accompanied by an increase in plasma viscosity which could produce a decrease of the neonatal diuresis with less physiological weight loss in the newborn after delivery. This event is related to a decrease of fetal plasma bicarbonate.

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