

# The effect of delivery on umbilical arterial cord blood gases and lipid peroxides: comparison of vaginal delivery and cesarean section

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## Summary

Umbilical arterial blood gas analysis is the most objective method to assess fetal well being at birth, is the gold standard assessment of uteroplacental function and fetal oxygenation/acid-base status at birth, and it excludes the diagnosis of birth asphyxia in approximately 80% of depressed newborns at term. This study was designed to determine the effect of the type of delivery on umbilical cord blood gases and on free radical activity together with antioxidation in the fetus.

Ninety-six pregnant women between 37 and 42 weeks of gestation were included to the study and randomly assigned to the one of three groups: Group 1 (n = 40) were vaginally delivered, Group 2 (n = 26) had cesarean section with epidural anaesthesia, and Group 3 (n = 30) had cesarean section under general anaesthesia. Umbilical artery blood gas analysis was performed just after the delivery of the fetus together with malondialdehyde and glutathione.

The umbilical arterial PO<sub>2</sub> was found to be higher in Group 3, and malondialdehyde and glutathione levels were lower in newborns of Group 2. It can be concluded that cesarean section with epidural anaesthesia is safer when lipid peroxides are concerned.

**Key words:** Umbilical cord blood gases; Lipid peroxide; Vaginal delivery; Cesarean section; Epidural anesthesia; General anesthesia.

## Introduction

Umbilical arterial blood gas analysis is the most objective method to assess fetal well being at birth [1]. It is also the gold standard assessment of uteroplacental function and fetal oxygenation/acid-base status at birth, and it excludes the diagnosis of birth asphyxia in approximately 80% of depressed newborns at term. A complete blood gas analysis may provide important information regarding the type and cause of acidemia. Many different factors during pregnancy, labour, and delivery can affect the cord blood gases [2].

The process of childbirth is accompanied by an increase in oxidative aggression. The fetus exchanges an intrauterine environment that is hypoxic, with pO<sub>2</sub> of 20-25 mm Hg and a low presence of free radicals, for another with a greater oxygen content, with pO<sub>2</sub> of 100 mm Hg and exposure of the pulmonary epithelial cells to pressures of about 140 mm Hg in inhaled air. This change results in greater oxidative stress simply due to the existence of normoxic levels in the new extrauterine environment. The oxidative aggression suffered by the neonate is counteracted by the maturation of effective antioxidant mechanisms such as the enzymatic systems (superoxide dismutase, catalase, glutathione peroxidase, etc) [3].

This study was designed to determine the effect of labour (normal spontaneous delivery, cesarean section under general anaesthesia, and cesarean section with epi-

dural anaesthesia) on umbilical cord blood gases and free oxygen radical activity as well as antioxidant counteraction in the fetus.

## Materials and Methods

Ninety-six pregnant women with a cephalic presentation were included in the study. All women were having singleton pregnancies, were between 37 and 42 weeks of gestation and delivered either vaginally without complications (Group 1, n = 40), or had elective cesarean section with epidural anaesthesia (Group 2, n = 26), or had elective cesarean section under general anaesthesia (Group 3, n = 30). None of the women suffered from medical diseases or had evidence of fetal distress prior to recruitment and none had taken medications throughout pregnancy, apart from iron supplementation. In all cases delivery resulted in healthy newborns with Apgar scores above 7 at 5 min.

Following delivery a segment of umbilical cord was immediately double clamped, and 5 ml of blood was drawn and filled into an EDTA (ethylene diamine tetra acetate) containing tube from the artery for malondialdehyde (MDA) and glutathione (GSH) analysis together with 2 ml of blood to a preheparinised plastic syringe for blood gas analysis.

The plasma in blood samples for MDA and GSH was collected immediately after refrigerated centrifugation at 1000 revolutions per minute for ten minutes, and then stored at -20°C until MDA and GSH were assayed. Blood gas analysis was performed using an AVL OMNI (AVL Co, Germany) blood gas analysis machine within five minutes of collection, and oxygen saturation, pH, pO<sub>2</sub>, pCO<sub>2</sub>, HCO<sub>3</sub><sup>-</sup>, base excess, and hematocrit levels were noted.

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The plasma malondialdehyde levels were estimated as reactive substances by a thiobarbituric acid adduction method described by Wasowicz *et al.* [4]. Fifty  $\mu\text{l}$  plasma samples were introduced into tubes each containing 29 mmol/l thiobarbituric acid (Sigma Chemical Co, Deisehofen, Germany) into acetic acid (8.75 mmol/l, pH of the reaction mixture; 2.4–2.6), the samples were placed in a water bath and heated for one hour at 95–100°C. After the samples had cooled under running cold water, 25  $\mu\text{l}$  of 5 mmol/l hydrochloric acid were added, the reaction mixture was extracted with 3.5 ml of n-butanol (Sigma Chemical Co., Deisehofen, Germany) and centrifuged at 3,000 g per minute for five minutes. After centrifugation, the butanol phase was separated and the fluorescence of the butanol extract was measured in a spectrofluorometer (Schimadzu-RF-5000, Kyoto, Japan), using 525 nm for excitation, and 547 nm for emission. The Beotler spectrophotometric measurement method [5] was used in detection of plasma GSH.

All epidural anesthesia patients had the same amount of drugs (50 mg bupivacaine + 100  $\mu\text{g}$  fentanyl + 10 ml isotonic solution) via an epidural catheter inserted from the L2–L3 intervertebral space. General anaesthesia was induced with propofol (2 mg/kg) and succinylcholine (1.5 mg/kg), and was continued with 0.7–1.3% isoflurane within 100% oxygen.

The results were compared between the three study groups, and the ANOVA (one-way analysis of variance) test was used for the statistical analysis, using the SPSS version 10.0 for Windows; a p value of < 0.05 was considered as significant.

## Results

There were no statistically significant differences between the groups regarding age (Group 1: 24.56 + 4.34 years, Group 2: 26.84 + 3.15 years, Group 3: 25.74 + 3.69 years), gestational age (Group 1: 38.5 + 1.5 weeks, Group 2: 39.5 + 1 weeks, Group 3: 40 + 1 weeks), birth weight and complications.

The umbilical arterial  $\text{pO}_2$  was significantly higher in Group 3, although other parameters of blood gas analysis together with hematocrit level did not differ between groups. Arterial plasma levels of MDA and GSH were significantly lower in newborns of Group 2 patients ( $p < 0.05$ ) (Table 1). A positive correlation between MDA and  $\text{pCO}_2$  was observed in Group 2 and Group 3 as well as between GSH and  $\text{pO}_2$  ( $p < 0.05$ ). There was no correlation between MDA or GSH and any other parameters in Group 1.

Table 1. — Umbilical arterial levels of pH,  $\text{pCO}_2$ ,  $\text{pO}_2$ ,  $\text{HCO}_3^-$ , BE, HTC, MDA, and GSH.

	Group 1	Group 2	Group 3	ANOVA
pH	7.35 $\pm$ 0.21	7.36 $\pm$ 0.18	7.35 $\pm$ 0.17	p = 0.904
$\text{pCO}_2$	37.93 $\pm$ 10.94	33.40 $\pm$ 9.16	38.03 $\pm$ 5.43	p = 0.268
$\text{pO}_2$	17.62 $\pm$ 5.19	23.78 $\pm$ 9.58	29.18 $\pm$ 10.63	p = 0.003
$\text{HCO}_3^-$	20.23 $\pm$ 2.75	20.84 $\pm$ 2.09	20.15 $\pm$ 1.64	p = 0.758
BE	-4.29 $\pm$ 1.89	-4.51 $\pm$ 1.29	-4.76 $\pm$ 1.21	p = 0.802
Htc	45.30 $\pm$ 3.24	42.49 $\pm$ 9.76	41.57 $\pm$ 8.16	p = 0.758
MDA	2.50 $\pm$ 0.37	1.99 $\pm$ 0.43	2.31 $\pm$ 0.54	p = 0.001
GSH	6.62 $\pm$ 1.89	5.77 $\pm$ 1.74	6.41 $\pm$ 1.46	p = 0.001

'p' is significant when < 0.05; BE: Base excess; Htc: Hematocrit; MDA: Malondialdehyde; GSH: Glutathione.

## Discussion

Perinatal hypoxia is known to be one of the major causes of perinatal morbidity and mortality [6]. Persistent intrauterine hypoxia may result in ischemia, leading to permanent damage of the brain. Hypoxic insults to tissues cause the formation of oxygen-derived free radicals, which in turn cause peroxidation of unsaturated fatty acids resulting in increased levels of aldehydic lipid peroxidation products such as malondialdehyde [4, 7, 8].

Determination of umbilical arterial acid base status provides important assessment of perinatal asphyxia, however pH and base excess were reported to reflect fetal metabolic adjustments rather than fetal damage [9, 10]. Cellular damage by free radical activity following hypoxia and reperfusion during labour was reported in a previous study [11], and use of lipid peroxidation was suggested to be used as a marker of hypoxia. Similarly malondialdehyde measurement was reported to be a sensitive indicator of intrapartum fetal stress. In this study the major product of lipid peroxidation (MDA), and a major antioxidant (GSH), together with acid-base status were determined in different types of delivery, and compared with each other.

In a study reported previously, the levels of thiobarbituric acid reactive substances, an indicative parameter for oxidative damage, were found to be higher in vaginal deliveries, and this was explained as a marker of fetal oxidative stress, secondary to the process of labour [12]. Kaya *et al.* [13] reported that umbilical arterial malondialdehyde concentrations were increased in breech infants compared to cephalic presentation. In our study the MDA level in newborns of patients delivered by cesarean section with epidural anaesthesia was found to be lower. This may be associated with the lack of stress of the normal process of labour, and the decreased anxiety of the patients due to the epidural anaesthesia. None of the pregnant women in our study had a breech delivery.

Umbilical artery MDA was reported to be negatively associated with pH and  $\text{pO}_2$  and positively associated with  $\text{pCO}_2$  [13, 14]. However the correlation was positive between MDA and  $\text{pCO}_2$  in our study indicating that hypoxia may affect both MDA and  $\text{pCO}_2$  causing both of them to be increased. The higher  $\text{pO}_2$  in Group 3 may be associated with the inspired oxygen which was 100%. The difference between Group 2 and Group 3 in MDA level may also be associated with high inspired oxygen, as oxygen itself may cause radicals to increase.

It can be concluded from these findings that cesarean section does not cause lipid peroxides to increase, oxygen delivery of mothers during delivery may affect the umbilical MDA level, and cesarean section with epidural anaesthesia is safer when lipid peroxides are concerned.

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