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Plasma immunoreactive beta-endorphin, ACTH and cortisol concentrations in mothers and their neonates immediately after delivery — their relationship to the duration of labor

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1 Introduction

Childbirth certainly ranks among the most stressful physiological events in the life of women in the reproductive age. During labor there exists a variety of maternal stressors ranging from the intensely physical/one of labor per se to the perceptive of pain associated with labor and to the psychological stressors of antenatal anxiety or anticipated joy of the expected baby. As to the infant, its major stressors during labor will probably be periods of hypoxia and mechanical trauma. Whether the fetus in parturition feels pain, which could contribute to reactive changes in its hormonal balance, remains for the time being, an open question [12].

The body responds to increased physical and psychological demands by increased release of hormones (such as ACTH and beta-endorphin chiefly from the anterior pituitary and cortisol from the adrenal cortex) into the blood stream [2, 6, 7, 11, 14]. These hormones serve to adapt the body — prominently its cardiovascular, energy-providing and perceptive systems — to the stress situation. They induce rapid and potent responses from the cell groups to be activated and can play an important role in preventing organic damages caused by extraordinary requirements to the body.

Beta-endorphin, a 31 amino acid peptide (molecular weight 3 466 daltons) with strong analgesic and opiate-like activity, and ACTH, a 39-

residue peptide (molecular weight 4 542 daltons) with corticosteroid-stimulating properties were found to originate from the same large 31 kilodalton precursor molecule [15]. This prohormone also contains in its amino acid chain alpha- and beta-melanocyte stimulating hormone. The name pro-opiomelanocortin has been accepted for this common precursor. GUILLEMIN et al. have demonstrated that ACTH is secreted concomitantly with beta-endorphin by the pituitary gland [3]. Beta-endorphin appears to be synthesized in the same cells as ACTH [4, 17].

The main objectives of the present report were to investigate which plasma concentrations of the three stress-related hormones assayed are to be encountered immediately postpartum, which relationships are in existence between the hormone levels in mother and infant, and, finally, whether and to what extent the duration of labor exerts some influence on the release of the single hormones.

2 Patients, materials and methods

2.1 Subjects

The study included 29 pregnant women, who were delivered vaginally of 29 healthy neonates. In 4 additional cases the women were submitted to cesarean section under general anesthesia because of imminent intrapartum fetal distress.

With the exception of one delivery at gestational week 35, all the deliveries studied took place at term (wks. 37 to 41).

The maternal age was 24.6 ± 6.1 years (range 13 to 39 yrs.). Eighteen of the mothers examined were primiparae.

The newborn infants had a mean birthweight of 3222 ± 332 g. In 18 cases, who had undergone vaginal delivery, the duration of parturition was less than 10 hours ("Group A"), in the remaining 11 cases the vaginal delivery took more than 10 hours ("Group B", table I). The mean duration of labor in Group A was 6.1 ± 2.1 hours, that in Group B 12.9 ± 1.6 hours. The state of vitality of the neonates — as assessed by the Saling-score* [13] — was generally good. In Group A the median Saling-score immediately postpartum was 10 points and 5 minutes later 11 points; in Group B it was only 9 points and that determined 5 minutes later amounted to 11 points. In each of the two groups there was one neonate suffering from transitory metabolic acidosis during labor (pHqu 40 7.15 and 7.20; pHqu 40 = pH after equilibration with 40 mm Hg CO₂).

In the 4 cases of cesarean section ("Group C") the delivery was accomplished within 9.6 ± 6.0 hours. For the production of general anesthesia, sodium thiopental was administered intravenously. Additional suxamethonium chloride was used as muscle relaxant. One newborn infant delivered by cesarean section was in a moderate state of depression immediately postpartum (6 points), but recovered quickly (10 points 5 minutes later).

2.2 Sample collection and preparation

Maternal venous blood and umbilical venous blood were obtained immediately after delivery, i. e. during the first 10 minutes after parturition. The blood was collected into chilled tubes containing EDTA which were placed into an ice bath and centrifuged within 10 minutes after

Table I. Duration of birth in the cases examined.

	Arithmetical mean and standard deviation (hrs.)	Range (hrs.)
Group A Vaginal delivery, duration of labor $\leq$ 10 hrs. n = 18	6.1 ± 2.1	3 to 10
Group B Vaginal delivery, duration of labor $>$ 10 hrs. n = 11	12.9 ± 1.6	11 to 16
Group C Cesarean section under general anesthesia n = 4	9.5 ± 6.0	4 to 18

the blood was drawn. Aliquots of the plasma were transferred into polypropylene test tubes for ACTH and beta-endorphin assay and into glass test tubes for cortisol assay. Until radioimmunoassay, the samples were stored at -20°C .

2.3 Radioimmunoassays

Beta-endorphin, ACTH and cortisol immuno-reactivity were determined by radioimmunoassay with reagents supplied by New England Nuclear, Boston, Ma., USA, by Commissariat à l'énergie atomique, Gif-sur-Yvette, France, and by Serono, Freiburg i. B., Federal Republic of Germany, respectively. Hormone measurements in the plasma of the mothers and their infants were always carried out within the same assay. The standard concentrations of the hormones were measured in triplicate, the patients' samples in duplicate.

For beta-endorphin radioimmunoassay ¹²⁵I-labeled human beta-endorphin was used as the tracer, synthetic human beta-endorphin was applied for the standard solutions. The endorphin antiserum from rabbit had full cross-reactivity with human beta-endorphin and 50 per cent cross-reactivity with beta-lipotropin at 50 per cent displacement and practically no cross-reac-

* The scoring criteria of Saling are similar to those of Apgar, optimal being 12 points.

tivity with human ACTH, alpha-endorphin, alpha-melanocyte-stimulating hormone, methionine enkephalin and leucine enkephalin. The separation of the bound and the free fractions was accomplished with the charcoal separation technique. The limit of detection of the assay was 50 pg beta-endorphin per ml plasma. At concentrations of 100 pg beta-endorphin per ml the intra-assay and inter-assay coefficient of variation ranged between 7 to 12 per cent and 9 to 13 per cent.

ACTH radioimmunoassay was carried out with ^{125}I -ACTH of porcine origin as the tracer, synthetic human ACTH 1–39 was applied for the standard concentrations. The ACTH antiserum was raised in rabbit against a porcine ACTH coupled with bovine serum albumin. It had 100 per cent cross-reactivity with human ACTH 1–39 and 1–24, 1.0 and 0.3 per cent reactivity with beta-endorphin and with beta-lipotropin respectively and no cross-reactivity with alpha- and beta-melanocyte-stimulating hormone. The hormone-antibody-complex was separated by means of activated charcoal ("Norit") from the free fraction. The RIA sensitivity was 10 pg ACTH per ml. The within-batch and between-batch-precision varied between 5 to 9 per cent and 12 to 15 per cent respectively.

For ^{125}I -cortisol radioimmunoassay an antiserum raised from the rabbit against cortisol-21-BSA was applied. The cross-reactivity of this antibody with corticosterone, cortisone, desoxycorticosterone and progesterone was found to be 9.5, 3.8, 0.5 and 0.1 per cent respectively at 50 per cent binding. The cortisol-antibody complex was precipitated by addition of a constant amount of polyethylene glycol solution (20 per cent) in phosphate buffer pH 7.5. The lower limit of detection of the assay was 10 ng cortisol per ml. At concentrations of 200 ng cortisol per ml the mean intra-assay and inter-assay coefficients of variation were 4.5 and 6.7 per cent.

3 Results

The plasma concentrations of the three stress hormones measured in the 29 women delivered vaginally and their neonates and in the 4 cases of cesarean section are represented in table II.

The plasma concentrations of beta-endorphin averaged 150.9 ± 16.3 pg/ml in the 18 mothers of Group A and 153.0 ± 12.8 pg/ml in the 11 mothers of Group B ($\bar{x} \pm \text{SEM}$). The corresponding neonatal plasma levels of beta-endor-

Table II. Means, standard errors and ranges of beta-endorphin, ACTH and cortisol in maternal and neonatal plasma samples drawn immediately postpartum from 33 deliveries with normal outcome. Conversion to SI units: 1 pg beta-endorphin (1–31)/ml = 288.52 fmol/l; 1 pg ACTH (1–39)/ml = 220.17 fmol/l; 1 ng cortisol/ml = 2.76 nmol/l.

	Beta-endorphin (pg/ml)		ACTH (pg/ml)		Cortisol (ng/ml)	
	Mother	Infant	Mother	Infant	Mother	Infant
Vaginal delivery duration of labor ≤ 10 hours: Group A n = 18	150.9 ± 16.3 (75–393)	239.2 ± 23.5 (132–468)	78.2 ± 16.5 (12–287)	98.0 ± 23.3 (6–370)	375.1 ± 25.2 (196–580)	160.1 ± 13.1 (49–311)
Vaginal delivery, duration of labor > 10 hours: Group B n = 11	153.0 ± 12.8 (85–208)	260.9 ± 37.1 (95–463)	98.2 ± 20.1 (29–238)	165.8 ± 39.6 (31–368)	416.5 ± 38.0 (240–644)	170.4 ± 13.5 (72–228)
Cesarean section under general anesthesia: Group C n = 4	111.8 ± 14.1 (78–145)	190.0 ± 16.8 (160–227)	73.0 ± 16.1 (33–104)	48.5 ± 17.1 (19–95)	331.7 ± 33.5 (257–418)	168.0 ± 20.4 (143–229)

phin were 239.2 ± 23.5 pg/ml (Group A) and 260.9 ± 37.1 pg/ml (Group B). Thus, the plasma beta-endorphin concentrations in the neonates after delivery were significantly higher than those in their mothers: Group A: $p < 0.01$, $\chi^2 = 7.71$; Group B: $p < 0.05$, $\chi^2 = 4.56$, 1 degree of freedom (figure 1).

The mean plasma ACTH levels observed in the women of Group A and Group B were 78.2 ± 16.5 pg/ml and 98.2 ± 23.3 pg/ml respectively. Again, the neonatal ACTH concentrations were higher than their maternal counterparts and amounted to 98.0 ± 23.3 pg/ml in Group A and 165.8 ± 39.6 pg/ml in Group B. Nevertheless, in the subject sample examined, the maternal-neonatal differences did not reach the statistically significant 95 per cent confidence limit. The ACTH concentrations in the neonates with protracted vaginal delivery (Group B), however, were significantly elevated above those of Group A: $p < 0.05$, $\chi^2 = 6.52$ (figure 2).

In all groups examined no correlation between the maternal-neonatal ACTH levels as well as between the beta-endorphin concentrations in the mothers and their infants could be found.

At comparative evaluation of maternal and neonatal plasma cortisol after delivery, the repeatedly described fact of a steep gradient between high cortisol concentrations in the mothers and low concentrations of this hormone in their neonates can be noticed in this study, too [7, 10]. The mean plasma cortisol level in the mothers of Group A is 375.1 ± 25.2 ng/ml, that in the mothers of Group B is slightly higher, i. e. 416.5 ± 38.0 ng/ml. The plasma concentrations of cortisol measured in the neonates of Group A averaged 160.1 ± 13.1 ng/ml and in the neonates of Group B 170.4 ± 13.5 ng/ml. In each of the cases examined, the individual plasma cortisol concentration in the neonate was lower than that in its mother, a proof of the highly significant difference between maternal and neonatal cortisol levels in plasma.

If one considers the mean ACTH values measured in Group A as a (normal) 100 per cent

Figure 1. Plasma beta-endorphin levels in mothers (pale columns) and their infants (dark columns) immediately postpartum; mean $\pm$ SEM.

Figure 2. Plasma ACTH levels in neonates immediately after delivery (mean $\pm$ SEM).

basis, corresponding mean ACTH levels in Group B were elevated to 168 per cent in the neonates and to 126 per cent in their mothers. Applying the same calculation to the mean beta-endorphin and cortisol concentrations, the figures were increased up to 110 per cent in Group B compared to the hormonal means in Group A.

In the 4 cases of Group C — cesarean section under general anesthesia — the mean maternal

Table III. Mean percentage deviations of the various hormone levels assayed in Group B and C in relation to the appropriate means in Group A. Mean hormone concentrations in Group A were applied as 100 per cent basis of comparison.

	Deviations from appropriate means in Group A (per cent of mean)					
	Beta-endorphin		ACTH		Cortisol	
	Mother	Infant	Mother	Infant	Mother	Infant
Group B	101	109	126	168	111	106
Group C	74	79	93	50	88	105

and infantile concentrations of the three hormones examined were generally lower than those in Group A and B (table II). The figures of their relative decrease can be taken from table III. Again, neonatal ACTH was the most responsive parameter among the plasma hormone levels assayed.

4 Discussion

The high beta-endorphin and ACTH levels to be found in the immediately delivered neonates reflect to some extent the strong secretion of the two polypeptides during parturition. Labor, even if it is normal, is obviously a powerful stressor for the nasciturus provoking an enormous activation in pituitary secretion [5]. Protracted labor appears to be an unusually potent stressor for the infant as assessed by its plasma ACTH concentrations immediately postpartum.

ACTH concentration in the neonatal plasma has proved to be a very sensitive parameter among the various stress hormone levels measured. Thus, in the cases of protracted vaginal delivery an extraordinary elevation in infantile plasma ACTH is to be observed which is accompanied by a far more moderate elevation in infantile beta-endorphin. Conversely, in the

cases of cesarean section under general anesthesia the infantile ACTH levels are much more depressed than those of beta-endorphin.

Although ACTH and beta-endorphin originate from the same precursor molecule and are secreted from the same cells, there is evidently only a loose parallelism between their levels in plasma. This finding is presumably caused by different pathways in the secretory and post-secretory metabolism of the two polypeptides.

Despite the high ACTH concentrations to be measured in the neonates immediately postpartum, their plasma cortisol levels are comparatively low [8, 9], and this in face of the observation that the human fetus at term secretes about 75% of its circulating cortisol and the maternal contribution is about 25% [1]. Plasma cortisol levels depend on the rate of secretion, biotransformation and removal. The latter is much influenced by the transcortin level which is much lower in the infant than in the mother [16]. As to cortisol production and secretion, one can assume that, different from later periods in human life, the ACTH stimulation in the fetus leads to a proportionally lesser synthesis and release of cortisol in comparison with other steroid hormones, e. g. estrogens, in whose biosynthesis specific adrenocortical enzyme activities are also involved.

Summary

In 29 cases of vaginal delivery with normal outcome and 4 cases of cesarean section, the concentrations of beta-endorphin, ACTH and cortisol were determined in maternal venous and umbilical venous plasma immediately

postpartum. According to duration of labor and mode of delivery the cases examined were classified into three groups: Group A (18 cases) = vaginal delivery of less than 10 hours' duration, Group B (11 cases) = vaginal

delivery of more than 10 hours' duration of labor, Group C (4 cases) = cesarean section under general anesthesia. With the exception of one, the deliveries took place at term. The 33 neonates were in a very good clinical state 5 minutes after parturition (11 Saling points as median value).

For measurement of the hormone concentrations radioimmunoassays were used.

In Group A the mean beta-endorphin concentration in maternal plasma amounted to 150.9 ± 16.3 pg/ml, that in neonatal plasma to 239.2 ± 23.5 pg/ml ($\bar{x} \pm$ SEM). In Group B plasma beta-endorphin, both maternal and neonatal, was slightly higher than in Group A: 153.0 ± 12.0 pg/ml (maternal) and 260.9 ± 37.1 pg/ml (neonatal). The differences between maternal and neonatal beta-endorphin levels were statistically significant: Group A $p < 0.01$, Group B $p < 0.05$; χ^2 -test.

The mean ACTH concentrations in the plasma of the newborn infants were also found to be considerably higher compared with those in the plasma of their mothers: Group A 78.2 ± 16.5 pg/ml (maternal) and 98.0 ± 23.3 pg/ml (neonatal); Group B 98.0 ± 20.1 pg/ml (maternal) and 165.8 ± 39.6 pg/ml (neonatal). The maternal-neonatal concentration differences, however, did not reach the statistically significant 95 per cent confidence limit. Again, maternal and neonatal hormone

concentrations proved to be more elevated in Group B than in Group A. The ACTH concentrations in the neonates with protracted vaginal delivery (Group B) were significantly elevated above those in the infants with a vaginal delivery of less than 10 hours' duration of labor (Group A): $p < 0.05$; χ^2 -test.

The cortisol determinations in mothers and their neonates confirmed the repeatedly described fact of high maternal and low neonatal plasma concentrations immediately postpartum. In none of the individual cases studied did the infantile cortisol level exceed the maternal level.

In Group C — cesarean section under general anesthesia — the mean concentrations of the three hormones examined were considerably depressed below the corresponding levels to be found in Group A and B. The circulating ACTH in the immediately delivered neonates responded with a particularly strong decrease.

Taken as a whole, the newborn infants immediately after vaginal delivery demonstrated strikingly high concentrations of the two stress-related polypeptides ACTH and beta-endorphin, which were increasing with prolonged duration of parturition. This finding is probably to be assessed as a hormonal response of the infant to its mechanical and metabolic impairment during the second stage of labor.

Keywords: ACTH, beta-endorphin, cesarean section under general anesthesia, cortisol, duration of labor, immediate postpartum period, maternal plasma concentration, neonate, stress, umbilical plasma concentration, vaginal delivery.

Zusammenfassung

Plasmakonzentrationen von immunoreaktivem beta-Endorphin, ACTH und Kortisol bei Müttern und Neugeborenen sofort nach der Entbindung — Beziehungen zur Wehrendauer

Bei 29 vaginalen Entbindungen mit normalem Ausgang und 4 Kaiserschnitt-Entbindungen wurden die Konzentrationen von beta-Endorphin, ACTH und Kortisol unmittelbar nach der Geburt im mütterlichen venösen und im Nabelvenen-Plasma bestimmt. Die untersuchten Fälle wurden nach Wehrendauer und Entbindungsart in drei Gruppen aufgeteilt: Gruppe A (18 Fälle) = vaginale Entbindungen von weniger als 10 Stunden Wehrendauer, Gruppe B (11 Fälle) = vaginale Entbindungen von mehr als 10 Stunden Wehrendauer, Gruppe C (4 Fälle) = Kaiserschnitt unter Narkose.

Mit einer Ausnahme erfolgten alle Entbindungen am Termin. Die 33 Neugeborenen waren 5 Minuten nach der Entbindung sämtlich in einem sehr guten klinischen Zustand (11 Saling-Punkte als Median).

Zur Messung der Hormonkonzentrationen wurden Radioimmunoassays durchgeführt.

In Gruppe A betrugen die mittlere beta-Endorphin-Konzentration im mütterlichen Plasma 150.9 ± 16.3 pg/ml, jene im Neugeborenenplasma 239.2 ± 23.5 pg/ml ($\bar{x} \pm$ SEM). In Gruppe B lag sowohl das mütterliche als

auch das kindliche Plasma-beta-Endorphin etwas höher als in Gruppe A: 153.0 ± 12.0 pg/ml (mütterlich) und 260.9 ± 37.1 pg/ml (kindlich). Die Unterschiede zwischen den mütterlichen und kindlichen beta-Endorphin-Spiegeln waren statistisch signifikant: Gruppe A $p < 0.01$, Gruppe B $p < 0.05$; χ^2 -Test.

Auch die mittleren ACTH-Konzentrationen im Plasma der Neugeborenen wurden beträchtlich höher gefunden verglichen mit denen ihrer Mütter: Gruppe A 78.2 ± 16.5 pg/ml (mütterlich) und 98.0 ± 23.3 pg/ml (kindlich); Gruppe B 98.0 ± 20.1 pg/ml (mütterlich) und 165.8 ± 39.6 pg/ml (kindlich). Die materno-neonatalen Konzentrationsunterschiede erreichten jedoch nicht die statistisch signifikante 95%-Vertrauensgrenze. Wiederum waren die Hormonkonzentrationen bei Müttern und Neugeborenen in der Gruppe B stärker erhöht als in der Gruppe A. Bei den Neugeborenen mit länger dauernder vaginaler Entbindung (Gruppe B) waren die ACTH-Konzentrationen deutlich über jenen von Kindern mit einer vaginalen Entbindungsdauer von weniger als 10 Stunden (Gruppe A) angehoben: $p < 0.05$; χ^2 -Test.

Die Kortisol-Bestimmungen bei Müttern und ihren Neugeborenen bestätigten die wiederholt beschriebene Tatsache von hohen mütterlichen und niedrigen kindlichen

Plasmakonzentrationen sofort post partum. In keinem der untersuchten Einzelfälle überschritt der kindliche Kortisol-Spiegel den mütterlichen.

In der Gruppe C – Kaiserschnitt in Narkose – lagen die mittleren Konzentrationen der drei untersuchten Hormone beträchtlich unter den entsprechenden Spiegeln der Gruppen A und B. Das zirkulierende ACTH der soeben Neugeborenen reagierte mit einer besonders starken Verminderung.

Schlüsselwörter: ACTH, beta-Endorphin, Kaiserschnitt in Narkose, Kortisol, mütterliche Plasmakonzentration, Nabelschnur-Plasmakonzentration, Neugeborenes, Periode unmittelbar nach der Entbindung, Streß, vaginale Entbindung, Wehendauer.

Résumé

Concentrations de béta-endorphine immuno-réactive plasmatique, d'ACTH et de cortisol chez les mères et leurs nouveaux-nés immédiatement après la naissance – relation avec la durée du travail

On a déterminé dans le sang veineux maternel et au sang veineux ombilical, immédiatement après la naissance, les concentrations de béta-endorphine, d'ACTH et de cortisol, chez 29 femmes ayant accouché par voie basse avec une évolution normale et chez 4 femmes césariées. On a classé les cas étudiés en trois groupes selon la durée du travail et le mode d'accouchement: groupe A (18 cas): accouchement par voie basse de moins de 10 heures; groupe B (11 cas): accouchement par voie basse de plus de 10 heures; groupe C (4 cas): césarienne sous anesthésie générale.

Les accouchements, sauf 1 cas, étaient à terme. Les 33 nouveaux-nés étaient en très bon état clinique 5 minutes après l'accouchement (11 points au score de Saling comme valeur moyenne). Les dosages hormonaux ont été effectués par dosages radio-immunologiques.

Dans le groupe A, les concentrations moyennes en béta-endorphine sont de $150,9 \pm 16,3$ pg/ml ($\bar{X} \pm \text{SEM}$) chez le nouveau-né. Dans le groupe B, les béta-endorphines plasmatiques sont légèrement plus élevées chez la mère et chez le nouveau-né que dans le groupe A: $153,0 \pm 12,0$ pg/ml (mère) et $260,9 \pm 37,1$ pg/ml (nouveau-né). Les différences entre les taux de béta-endorphines maternelles et fœtales sont significatives sur le plan statistique: groupe A, $p < 0,01$; groupe B, $p < 0,05$; test du χ^2 .

Les concentrations plasmatiques moyennes en ACTH chez les nouveaux-nés sont également considérablement plus élevées que les concentrations plasmatiques de leurs mères:

Im Ganzen zeigten die Neugeborenen sofort nach der vaginalen Geburt auffällig hohe Konzentrationen der beiden streßbezogenen Polypeptide ACTH und beta-Endorphin, die bei verlängerter Geburtsdauer noch weiter stiegen. Dieser Befund ist wahrscheinlich als hormonale Reaktion des Kindes auf seine vorangegangene mechanische und metabolische Beeinträchtigung in der Austreibungsphase zu bewerten.

groupe A: $78,2 \pm 16,5$ pg/ml (mère) et $98,0 \pm 23,3$ pg/ml (nouveau-né);

groupe B: $98,0 \pm 20,1$ pg/ml (mère) et $165,8 \pm 39,6$ pg/ml (nouveau-né).

Les différences materno-fœtales ne sont pas toutefois significatives sur le plan statistique. De nouveau, les concentrations hormonales maternelles et fœtales sont plus élevées dans le groupe B que dans le groupe A. Les concentrations en ACTH chez les nouveaux-nés après un accouchement par voie basse prolongé (groupe B) sont significativement plus élevées que celles des enfants nés après un travail de moins de 10 heures (groupe A): $p < 0,05$; test du χ^2 .

Les dosages de cortisol chez les mères et leurs nouveaux-nés ont confirmé le fait déjà décrit de taux maternels élevés et de taux plasmatiques néonataux bas, immédiatement après la naissance. Les taux de cortisol chez les enfants ne sont supérieurs aux taux maternels dans aucun des cas individuels étudiés.

Dans le groupe C (césariennes sous anesthésie générale), les concentrations moyennes des trois hormones étudiées sont considérablement abaissées au-dessous des taux correspondants trouvés dans les groupes A et B. L'ACTH circulante chez les nouveaux-nés juste après l'extraction présente une diminution particulièrement importante.

Pris dans leur ensemble, les enfants nouveaux-nés, immédiatement après l'accouchement par voie basse, montrent des concentrations élevées particulièrement frappantes des deux polypeptides liés au stress, ACTH et béta-endorphine, qui augmentent avec l'allongement de la durée de la parturition. Cette donnée est probablement à estimer comme une réponse hormonale des enfants à ses troubles mécaniques et métaboliques au cours de la seconde partie du travail.

Mots-clés: Accouchement par voie basse, ACTH, béta-endorphines, césarienne sous anesthésie générale, concentration plasmatique maternelle, concentration plasmatique ombilicale, cortisol, durée de travail, nouveau-né, période post-partum immédiate, stress.

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