

ORIGINAL ARTICLE

STUDY OF THE STATE OF STRESS-IMPLEMENTING SYSTEMS IN ABDOMINAL DELIVERY DEPENDING ON ANESTHETIC TECHNIQUES

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ABSTRACT

The aim: Evaluation of stress-protective effects of various anesthetic techniques on Cesarean section (CS).

Materials and methods: 127 pregnant women who delivered by cesarean section, were divided into 4 subgroups: 1a (n = 31) – general anesthesia (GA) with ketamine, 1b (n = 31) – GA with sodium thiopental, 2a (n = 31) – spinal anesthesia (SA), 2b (n = 34) – SA with intravenous administration of ondansetron at a dose of 8 mg. The assessment was performed at 5 stages: 1 – initial; 2 – infant extraction; 3 – 6 hours after surgery; 4 – 12 hours after surgery.

Results: At stage 2, insulin levels in 1a and 1b subgroups decreased by 23.9% and 34.1%, while in 2a and 2b subgroups there were no significant changes. There was an increase in the levels of cortisol, prolactin and cortisol/insulin ratio at the 2 and 3 stages in the 1a and 1b subgroups. Pain intensity increased by the 3 stage in patients of all groups. It was the highest in the 1a and 1b subgroups. At the 4 stage, pain intensity was reduced in all groups, remaining significantly higher in patients of 1a and 1b subgroups.

Conclusions: The dynamics of the content of stress hormones, the pain intensity in patients undergoing CS under SA give reason to consider this method as an optimal and adequate one for protection from surgery stress.

KEY WORDS: cesarean section, stress hormones, vegetative regulation, general anesthesia, spinal anesthesia

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INTRODUCTION

Cesarean section (CS) is an indispensable operation that helps to reduce maternal and perinatal infant morbidity and mortality [1]. Selection of anesthetic technique for abdominal delivery is aimed at providing adequate protection of the mother and the fetus from stress reactions caused by surgical trauma [2]. Surgery stress (endocrine, metabolic and inflammatory) response is the most important inducer of dysfunction of various organs and systems (pain, catabolism, pulmonary dysfunction, increased myocardial oxygen demand, gastrointestinal paresis, imbalance and fibrinolysis) [3]. The impact of stress during CS has a negative effect on both the mother and the newborn (post-traumatic stress disorder in women after cesarean section, delayed onset of lactation) [4]. In case of a surgical trauma, somatic impulses from the wound reach the hypothalamus, causing release of hypothalamic releasing hormones, which, in turn, stimulate secretion of the anterior and posterior pituitary hormones [5; 6]. Dynamics of plasma concentration of cortisol, insulin and prolactin is an adequate reflection of the organism response to stress [7-9].

In response to surgery stress, adaptive-compensatory reactions of the organism are formed at the same time, the leading role in formation of which is played by the autonomic nervous system (ANS). The ability to adapt depends largely on the initial state of the ANS. Together with vegetative reactivity and vegetative support, it allows for evaluating homeostatic parameters and adaptive capacity of the organism to stressful conditions [10].

Persons with parasympathicotonic and eutonic type of regulation have a high probability of adequate changes in hemodynamic indices under psycho-emotional stress and physical activity; whereas persons with sympathicotonic type of autonomic regulation have a high probability of excessive stress [11]. Determination of vegetative status helps to define the functional capabilities of the organism and thus to evaluate adaptation reserves.

THE AIM

The study purpose is to evaluate the stress-protective effects of various anesthetic techniques comprehensively for further development of an algorithm for optimal method of anesthetic technique selection during surgery.

Table I. Distribution of patients depending on CS performing time.

CS	Study groups			
	1a (n=31)	1b (n=31)	2a (n=31)	2b (n=34)
Planned	7(22.6±7.5%)	7(22.6±7.5%)	21(67.7±8.4%)	6(17.6±6.5%)
Urgent	24(77.4±7.5%)	24(77.4±7.5%)	10(32.3±8.4%)	28(82.3±6.5%)

MATERIALS AND METHODS

The study included 127 pregnant women (average age 29.8 ± 0.5), who were admitted for delivery to public non-commercial utility company "Kharkiv Clinical Maternity Hospital No. 6" from 2015 to 2018. Inclusion criteria: pregnant women aged 18 to 45 with a gestational period of 36-40 weeks. Exclusion criteria: patients in a state of shock of any etiology; decompensated cardiopulmonary pathology; technical failures when performing spinal puncture.

The maternity patients were divided into 2 groups. Group 1 (n = 62) – CS was performed under conditions of multicomponent general intravenous (IV) anesthesia against total myoplegia with artificial lung ventilation (ALV). In this group, the patients were divided into two subgroups depending on the general anesthetic used: 1a (n = 31) – induction (1-2 mg/kg) and maintenance of anesthesia (1 mg/kg) were performed with a 5% ketamine solution; 1b (n = 31) – induction (3-5 mg/kg) and maintenance of anesthesia (1-2 mg/kg) was performed with 1% sodium thiopental solution.

Group 2 (n = 65) – operative delivery was performed under conditions of spinal anesthesia (SA). Spinal puncture (SP) was performed seated at the level L 3-4 with a Quincke needle 25-27 G. Intrathecal 0.5% solution of bupivacaine at a dose of 12-16 mg was added with addition of an adjuvant – 0.01% solution of clonidine at a dose of 0.5 ml. This group of maternity patients was also divided into two subgroups: 2a (n = 31) – SP was performed with central access; 2b (n = 34) – SP was performed with parametric access, and IV ondansetron at a dose of 8 mg was administered 5 minutes before the puncture.

Patients of all groups were premedicated with a 0.1% solution of atropine sulfate at a dose of 0.01 mg/kg. Total myoplegia before tracheal intubation for group 1 maternity patients was provided by IV introduction of a 2% solution of succinylcholine at a dose of 1-2 mg/kg; analgesia was provided by fractional injection of 0.005% solution of fentanyl at a dose of 1-2 μg/kg after infant extraction.

Planned CS was performed in 41 women (32.3 ± 4.1%); 86 (67.7 ± 4.1%) delivered in an urgent manner (Table I).

The degree of operational risk was assessed on the ASA scale. Body mass index (BMI) was calculated by the following formula I.

$$BMI = m/h^2 \qquad (I)$$

where m is the body weight, and h is the height in meters.

The pain intensity (PI) was measured at rest and on coughing using a visual analogue scale (VAS).

Hemodynamic monitoring was performed, which included monitoring of heart rhythm and heart rate. Non-invasive measurement of blood pressure indicators – systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) – was also performed. Oxygen saturation (SpO_2) was determined by means of patient monitoring using "Leon" apparatus, which meets the requirements of CISPR11 Class A (EN55011, Germany).

In order to determine stress-implementing systems in patients, a complex approach was used, which consisted of determining vegetative status by calculating the vegetative index (VI) by the following formula II.

$$VI = (1 - DBP/HR) * 100 \qquad (II)$$

where DBP is an indicator of diastolic blood pressure, HR is heart rate per 1 min.

The index value from -15 to +15 indicates total vegetative balance in the cardiovascular system; the value which is more than 15 indicates predominance of sympathetic effects of the autonomic nervous system; the digital value which is less than -15 indicates increased tone of parasympathetic compartment [12; 13].

Study of the level of such hormones as cortisol, insulin and prolactin was performed by means of enzyme immunoassay (Elx-800 enzyme immunoassay photometer, BioTek Instruments, Inc., USA) and a set of reagents for prolactin enzyme immunoassay "Prolaktin-IFA", insulin enzyme immunoassay "Insulin-IFA" and cortisol "Kortizol-IFA" enzyme immunoassay (HEMA Co., Ltd., Russia). Glycaemia level was determined using a biochemical automatic analyzer VITROS 350, Ortho-Clinical Diagnostics, Inc., USA, Liquick Cor-GLUCOSE (PZ CORMAY SA, Poland). The ratio of cortisol/insulin (C/I) was studied: it was calculated by the following formula III**.** Calculation formula C/I is developed by Panin L. E. [14]

$$C/I = \frac{C(at\ study\ stage)*100\%/C(before\ surgery)}{I(at\ study\ stage)*100\%/I(before\ surgery)} \qquad (III)$$

where C is plasma concentration level of cortisol, I is plasma concentration level of insulin.

The assessment was carried out in four stages: 1 – initial; 2 – infant extraction; 3 – 6 hours after surgery; 4 – 12 hours after surgery.

Statistical processing of results was performed using the computer program for Windows the SPSS 19 (USA). Quantitative and qualitative variables were used in the statistical analysis. Qualitative data were presented as percentages, and quantitative ones – in the form of mean and standard error (M ± m). The Pearson correlation coefficient was used to determine the relationship between qualitative variables. The critical significance level for testing statistical hypotheses in the study was set at 0.05.

Table II. Analysis of clinical anamnesis data of maternity patients in groups.

Criteria	Group 1		Group 2	
	1a (n=31)	1b (n=31)	2a (n=31)	2b (n=34)
Age, years	28.1 ± 0.9	29.1 ± 0.9	30.1 ± 0.8	31.3 ± 0.9
Gestational age, weeks	38.1 ± 0.4	38.2 ± 0.2	38.3 ± 0.2	38.3 ± 0.3
Duration of surgery, minutes	38.9 ± 1.1	40.3 ± 1.6	38.2 ± 1.6	37.5 ± 1.4
Infant extraction duration, minutes	4.8±0.3	4.8±0.3	5.5±0.3	5.1±0.3
BMI, kg/m^2	24.2±0.8	25.7±1.2	24.5±0.7	23.8±0.7

Table III. Types of VNS regulation based on VI at the stages of the study.

Stage	Vegetative regulation type	Group 1		Group 2	
		1a (n=31)	1b (n=31)	2a (n=31)	2b (n=34)
1	eutonic	10 (32.3±8.4%)	21 (67.7±8.4%)	17 (54.8±8.9%)	24 (70.6±7.8%)
	sympathicotonic	18 (58.6±8.9%)	5 (16.1±6.6%)	10 (32.3±8.4%)	9 (26.5±7.6%)
	vagotonic	3 (9.7±5.3%)	5 (16.1±6.6%)	4 (12.9±6.0%)	1 (2.9±2.9%)
2	eutonic	5 (16.1±6.6%)	8 (25.8±7.9%)	4 (12.9±6.0%)	10 29.4±7.8%)
	sympathicotonic	26 (83.9%±6.6%)	22 (70.9±8.1%)	26 (83.9%±6.6%)	23 (67.5%±8.0%)
	vagotonic	0 (0.00±0.00%)	1 (3.2±3.2%)	1 (3.2±3.2%)	1 (2.9±2.9%)
3	eutonic	11 (35.5±8.6%)	22 (70.9±8.1%)	18 (58.6±8.9%)	23 (67.5±8.0%)
	sympathicotonic	20 (64.5±8.6%)	6 (19.3±7.1%)	10 (32.3±8.4%)	6 (17.6±6.5%)
	vagotonic	0 (0.00±0.00%)	3 (9.7±5.3%)	3 (9.7±5.3%)	5 (14.7±6.1%)
4	eutonic	11 (35.5±8.6%)	22 (64.7±8.2%)	16 (51.6±8.9%)	23 (67.5±8.0%)
	sympathicotonic	19 (55.9±8.5%)	4 (12.9±6.0%)	10 (32.3±8.4%)	9 (26.5±7.6%)
	vagotonic	1 (3.2±3.2%)	5 (16.1±6.6%)	5 (16.1±6.6%)	2 (5.9±4.0%)

RESULTS

The maternity patients were representative by the main indicators: age, gestational age, duration of surgery and infant extraction (Table II).

The results analysis showed that no statistically significant intergroup differences at initial ANS status were detected among admitted maternity patients ($p > 0.05$). The initial eutonic type of regulation of the autonomic nervous system is predominant. 31 patients (50.0 ± 6.3%) of 1a and 1b subgroups and 41 patients (63.1 ± 6.0%) of 2a and 2b subgroups had the initial eutonic type of regulation of the autonomic nervous system; 23 patients (37.1 ± 6.1%) of 1a and 1b subgroups and 19 patients (29.2 ± 5.6%) of 2a and 2b subgroups had the sympathicotonic type of regulation; 8 patients (12.9 ± 4.3%) of 1a and 1b subgroups and 5 patients (7.7 ± 3.3%) of 2a and 2b subgroups had the vagotonic type of regulation. Most women were characterized by complete autonomic balance and were predicted to develop sufficient adaptive responses to stress, including surgical one. During the study at the stage 2, redistribution of influence of the ANS parts took place. A significant predominance of sympathetic VNS activity was found in patients of all groups, which is an objective indicator and a marker of emotional reactions and presence of stress reaction. 45 patients (72.6 ± 5.7%) had a sympathicotonic type, and 16 patients (25.8 ± 5.6%) had a eutonic type of VNS regulation ($p < 0.05$). In patients undergoing spinal anesthesia,

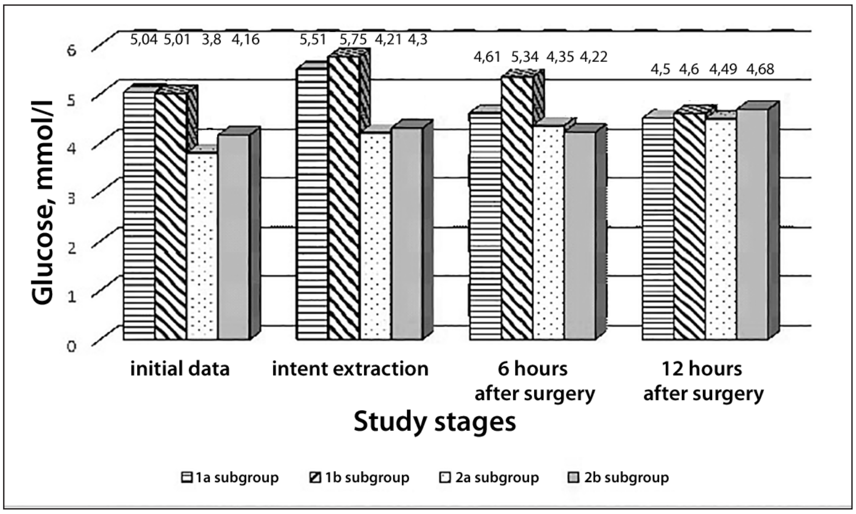

Fig. 1. Dynamics of plasma glucose concentration at the main stages of the study.

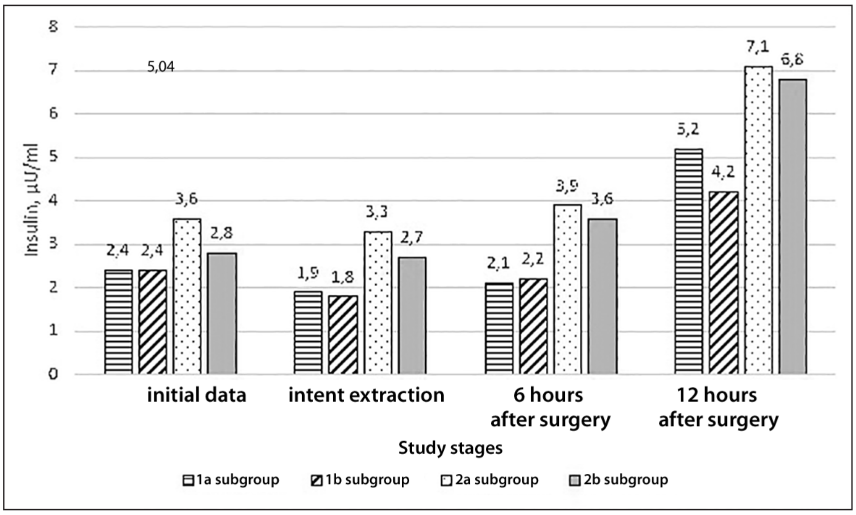

Fig. 2. Dynamics of plasma insulin concentration at the stages of the study.

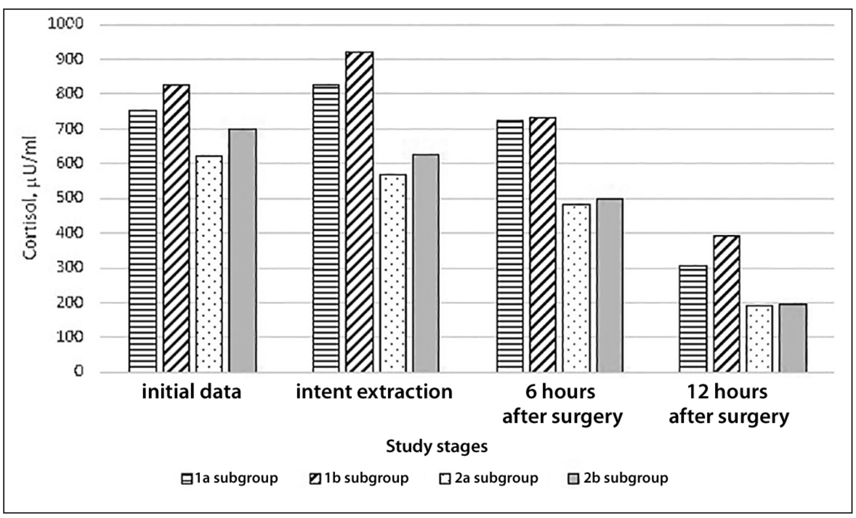

Fig. 3. Dynamics of plasma cortisol concentration at the stages of the study.

the autonomic tone at stage 3 returned to the initial level: 41 women (63.1 ± 6.0%) had a eutonic type, and 16 women (24.6 ± 5.3%) had a sympathicotonic type of ANS regulation, whereas sympathicotonia was maintained at all stages of the study in patients of 1a and 1b subgroups, which may indicate a violation of the mechanisms of adaptation to stressful conditions. These patients can be classified to the risk group for development of complications (Table III).

During the study of the hormonal link, there were no statistically significant intergroup differences in initial levels of cortisol, prolactin and insulin. Initial blood glucose levels in patients of 1a and 1b subgroups were significantly

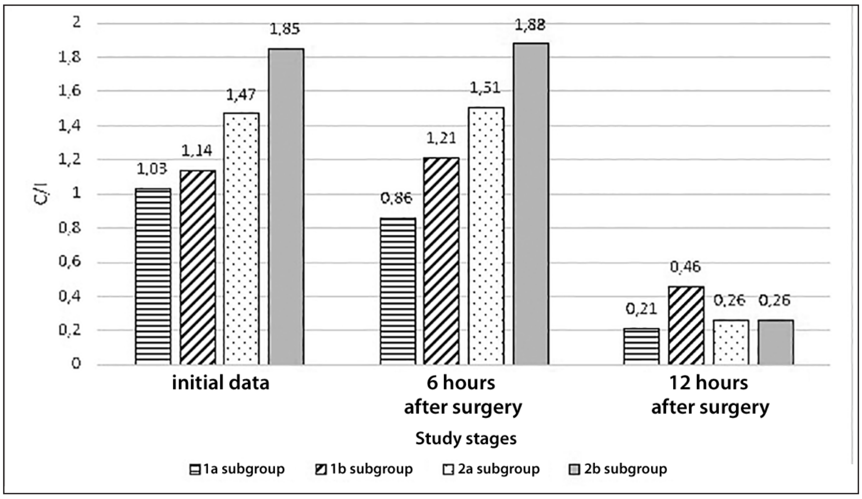

Fig. 4. C/I dynamics at the stages of the study.

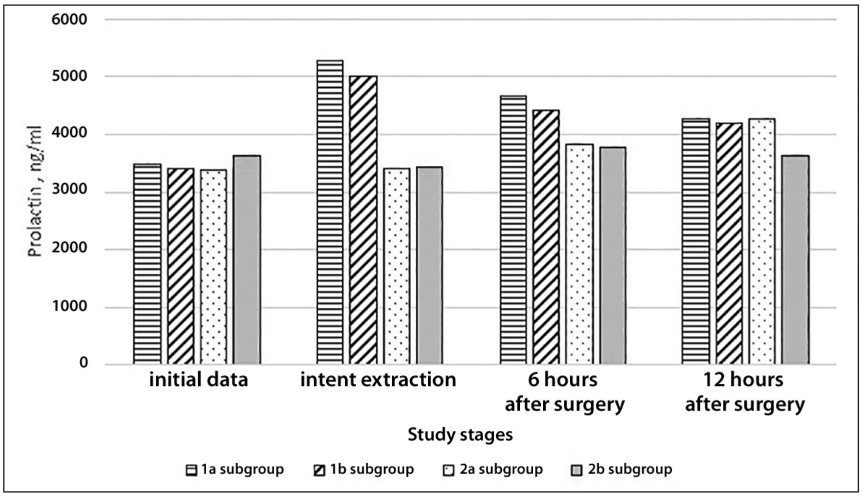

Fig. 5. Dynamics of plasma prolactin concentration at the stages of the study.

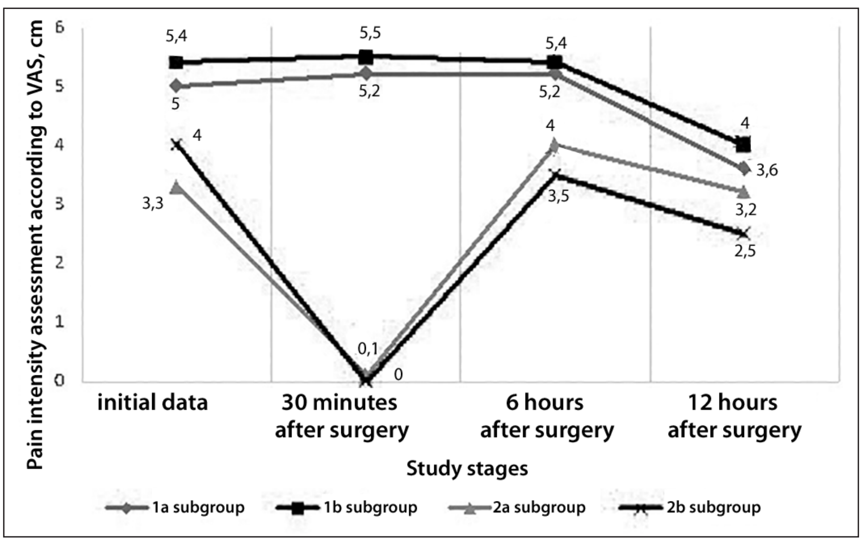

Fig. 6. Dynamics of pain intensity et rest according to VAS in study groups at the main stages of the study.

higher (Table III). Hypoglycemia (3.8 ± 0.2 mmol/l) was initially observed in subgroup 2b women. Most likely, this fact is related to a greater number of patients, who underwent planned delivery with the use of enteral nutrition restriction before surgery, in this group (Fig. 1).

At stage 2, blood insulin concentration decreased significantly in women undergoing general anesthesia during cesarean section: in women of subgroup 1a – by 23.9% ($p < 0.05$), in subgroup 1b – by 34.1% ($p < 0.05$) from IL (initial level), whereas in women for whom CS was performed in SA conditions at stage 2, insulin levels approached IL, remaining so without significant variations until stage 3 (Fig. 2). Insulin levels in patients of 1a and 1b subgroups by stage 4 significantly increased twice ($p < 0.001$), but remained significantly

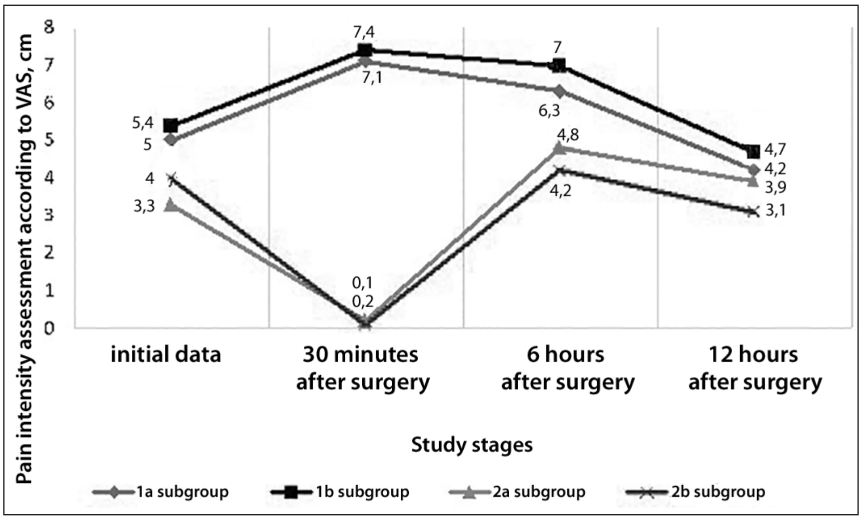

Fig. 7. Dynamics of pain intensity on coughing according to VAS at the main stages of the study.

Table IV. Indicators of plasma concentrations of stress hormones and glucose levels at the stages of the study

Stage	Group 1		Group 2	
	1a (n=31)	1b (n=31)	2a (n=31)	2b (n=34)
	Glucose (mmol/l)			
1	5.04±0.2*	5.01±0.2^	3.8±0.2	4.16±0.3
2	5.51±0.2*	5.75±0.2^^	4.21±0.1^	4.30±0.2**
3	4.61±0.2	5.34±0.2	4.35±0.2^	4.22±0.2^^
4	4.12±0.1	4.6±0.1	4.49±0.1	4.68±0.1**
	Insulin (µU/ml)			
1	2.4±0.9	2.4±0.3	3.6±0.4	2.8± 0.3
2	1.9±0.2*	1.8±0.2	3.3±0.3^	2.7±0.3
3	2.1±0.2*	2.2±0.2^^	3.9±0.3^	3.65±0.2**
4	5.2±0.3*	4.2±0.3^^	7.1±0.3^	6.8±0.3**
	Cortisol (nmol/l)			
1	753.7±46.9	752.6±54.9	623.6±60.1	699.9±55.6
2	826.3±50.8*	922.5±52.5	569.5±37.04^	623.9±42.1^^
3	725.3±39.1*	732.5±46.2^^	481.9±32.4^	499.4±29.72**
4	305.2±24.3*	392.03±28.4^^	190.9±19.6^	194.4±20.3**
	C/I			
2	1.47±0.1	1.85±0.2	1.14±0.1^	1.03±0.9^^
3	1.51±0.3	1.88±0.6	1.21±0.2	0.86±0.2
4	0.21±0.3	0.46±0.1	0.26±0.1	0.26±0.1
	Prolactin (ng/ml)			
1	3482.1±183.17	3402.9±100.2	3387.1±155.5	3626.1±215.5
2	5271.04±242.7*	5003.5±193.6^^	3411.2±222.9^	3443.1±257.6**
3	4652.7±168.7	4424.3±95.02^^	3830.1±202.7	3785.7±112.8**
4	4272.4±118.6*	4205.1±140.1	4272.1±118.6^	3625.3±172.8

Notes: * – statistical significance of differences in indicators (p <0.001) between 1a and 2a subgroups;
** – statistical significance of differences in indicators (p <0.001) between 1a and 2b subgroups;
^ – statistical significance of differences in indicators (p <0.001) between 1b and 2a subgroups;
^^ – statistical significance of differences in indicators (p <0.001) between 1b and 2b subgroups.

lower compared to rates in 2a and 2b subgroups (Table III). The concentration of insulin in women who delivered under general anesthesia using sodium thiopental was significantly lower at all stages of the study ($p < 0.001$). During the study of insulin levels, no statistically significant differences were found between subgroups 2a and 2b ($p > 0.05$).

We found an increase in the concentration of cortisol at the 2 stage of the study compared with IL in patients who underwent CS under general anesthesia. In women of 2a and 2b subgroups, the plasma concentration of cortisol decreased slightly at this stage ($p < 0.001$) (Fig. 3). At the 3 stage of the study, a significant difference was also observed: 6 hours after surgery in subgroups 2a and 2b level there was a decrease in cortisol concentration by 29.4% ($p < 0.001$) and by 40.1% ($p < 0.001$), respectively, compared to IL, whereas cortisol levels in subgroups 1a and 1b were close to IL (Table III). At the 4 stage of the study, 12 hours after surgery, the plasma concentration level decreased in all groups, remaining significantly higher in the group of women who delivered under general anesthesia using sodium thiopental ($p < 0.001$). When comparing the plasma concentration of cortisol in patients of 2a and 2b subgroups, no significant statistical difference was found at all stages of the study ($p > 0.05$).

C/I is the main indicator of intensity of adaptation and severity of stress reactions in the organism. The study found high C/I values at stage 2 in women of 1a and 1b subgroups, which remained elevated at stage 3 as well. Patients of 2a and 2b subgroups showed a statistically insignificant increase of C/I ratio at stage 2 compared to initial level ($p > 0.05$) with a decrease of this factor by stage 4 (Fig. 4).

The study of blood prolactin levels revealed a statistically significant increase in the concentration of this hormone at the 2 stage of the study in patients of 1a and 1b subgroups by 51.4% ($p < 0.001$) and 47.0% ($p < 0.001$), respectively, and the increase of prolactin concentration in patients of 2a and 2b groups remained statistically insignificant ($p > 0,05$) (Fig. 5). At the 3 stage of the study, the level of prolactin in the peripheral blood of patients of all groups was determined within the age limits. It shall be noted that it was the highest in women who delivered under general anesthesia (subgroups 1a and 1b) – 4652.7 ± 168.7 ng/ml and 4424.3 ± 95.02 ng/ml, which was significantly different from prolactin concentrations in women who delivered under spinal anesthesia (subgroups 2a and 2b) – 3830.1 ± 202.7 ng/ml and 3785.7 ± 112.8 ng/ml ($p <0.001$). No significant statistical differences ($p >0.05$) were observed between the concentrations of this hormone in patients of 2a and 2b subgroups at all stages of the study (Table III).

There were no statistically significant differences in initial pain intensity in patients in all groups. PI according to VAS in the study groups increased by stage 3 of the study. The PI level at rest in 1a and 1b subgroups was higher – 5.2 ± 0.2 cm and 5.4 ± 0.2 cm ($p < 0.001$; $p < 0.001$) than in patients of 2a and 2b subgroups – 3.9 ± 0.2 cm and 3.5 ± 0.2 cm ($p < 0.001$; $p < 0.001$). By the 4 stage of the study PI was significantly decreased in patients of all groups; significantly higher level of pain at rest was observed in patients of 1a and 1b of subgroups – 3.6 ± 0.1 cm ($p < 0.001$) and 4.0 ± 0.1 cm ($p < 0.001$) compared with 2a and 2b subgroups – 3.2 ± 0.2 cm and 2.5 ± 0.1 cm, respectively ($p < 0.001$; $p < 0.001$) (Fig. 6).

On coughing, the pain was more pronounced compared to the state at rest in patients of both groups. It was the highest in the subgroup 1b patients and was equal to 4.7 ± 0.2 cm, which was significantly different from the pain level according to VAS in 1a subgroup – 4, 2 ± 0.2 cm ($p < 0.001$) and in patients of 2a – 3.9 ± 0.2 cm and 2b – 3.1 ± 0.1 cm ($p < 0.001$) subgroups. Pain on coughing according to VAS in patients in both subgroups of group 2 was lower compared with PI in women in group 1 ($p < 0.001$) (Fig. 7).

In our study, a relationship was found between the qualitative assessment of pain intensity according to VAS and the level of stress hormones. There is a significant correlation between pre-operative VAS PI and pre-operative cortisol and insulin concentrations: VAS – cortisol ($r = 0.68$; $p < 0.001$), VAS – insulin ($r = -0.62$; $p < 0.001$). There is a moderate positive correlation between pre-operative VAS PI and pre-operative glucose and prolactin concentration: VAS – glucose ($r = 0.37$; $p < 0.001$), VAS – prolactin ($r = 0.44$; $p < 0.001$). There is a moderate correlation between VAS PI 6 hours after surgery and cortisol and insulin levels in stage 4: VAS – cortisol ($r = 0.34$; $p < 0.001$), VAS – insulin ($r = -0.38$; $p < 0.001$). There is a weak positive correlation between VAS PI and glucose and prolactin levels 6 hours after surgery: VAS – glucose ($r = 0.260$; $p < 0.05$), VAS – prolactin ($r = 0.264$; $p < 0.05$). There is a weak positive correlation between VAS PI 12 hours after surgery and cortisol and prolactin levels at stage 5: VAS – cortisol ($r = 0.182$; $p < 0.05$), VAS – prolactin ($r = 0.223$; $p < 0.05$), and a negative weak correlation with insulin at stage 5 ($r = -0.274$; $p < 0.05$).

Thus, the higher is VAS PI, the higher are the peripheral blood glucose and cortisol levels are, and the lower is the peripheral blood insulin level.

DISCUSSION

Vegetative regulation is one of the most important mechanisms of adaptation to stressful conditions. That is why studying the clinical manifestations of predominance of certain parts of the ANS can be an objective indicator of the presence and degree of stress response. In a comparative study of severity of stress reactions when using total intravenous anesthesia during surgery and during the early postoperative period, unidirectional activation of the sympathoadrenal system and the pituitary gland are observed. Cortisol plays the most significant role in the organism response to surgical trauma. The level of plasma cortisol concentration is an adequate reflection of the organism response to surgery stress [3;15-17]. Deficiency of insulin secretion related to stress factors is caused by α-adrenergic inhibition of β-cells secretion with the development of insulin resistance [18]. Deficiency of insulin secretion is combined with catabolic hyperglycemic reaction of the organism. With the extreme influence of various factors that contribute to development of stress, there is an increase of blood prolactin level, and its dynamics largely depends on duration and intensity of this effect [19].

Intra- and postoperative increase of plasma concentration of cortisol, prolactin, cortisol-insulin index, decrease of insulin level in the group of patients operated under conditions of general anesthesia, showed its inability to protect hypothalamic-adrenal structures and sympathies from intra- and postoperative activation.

During CS under local anesthesia, both afferent entrance from the area of operation to the CNS and hypothalamic-pituitary axis are blocked, as well as efferent vegetative leading pathways to the liver and adrenal glands. Such blockade suppresses adrenocortical and glycemic responses to surgery, as evidenced by lower concentrations of stress-releasing hormones and cortisol-insulin ratio. The use of local anesthesia (compared to total intravenous anesthesia) tends to provide adequate protection, which is more significant, from stress reactions caused by surgery.

CONCLUSIONS

1. Redistribution of the influence of parts of the ANS in the intra- and postoperative periods in the groups of patients who delivered under general anesthesia is regarded as the organism response to surgery stress. A group of women with initial sympathicotonic type of CNS regulation had initial autonomic tension and cardiovascular load and may be considered at risk for complications.
2. The dynamics of concentration of stress hormones and pain intensity in patients who delivered under spinal anesthesia give reason to consider this method of anesthesia as an optimal and adequate one for protection of patients from surgery stress.
3. The results will allow to develop a mathematical model of selecting the optimal anesthetic technique for each patient individually, considering the initial vegetative tone, which will reduce undesirable and side effects of anesthesia and increase the accelerated recovery of women after cesarean section surgery.

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