AZJCVS

AZerbaijan Journal of CardioVascular Surgery

AZJCVS 2021;2(2):46-50

DOI: 10.30546/azjcvs.2021.2.2.28

Original Article

Comparative evaluation of bis monitor indicators and stress hormone levels the adequacy of anesthesia

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Received: 13 January, 2021
Accepted: 02 June , 2021
Published: 05 November, 2021

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CITATION

Hasanov F, Gasimova S, Muradov N, Namazova K. Comparative evaluation of bis monitor indicators and stress hormone levels the adequacy of anesthesia. AZJCVS. 2021;1(2):46-50. DOI: 10.30546/azjcvs.2021.2.2.28

Abstract

Aim: The aim of our research is to study the role of monitoring BIS (bispectral index) and stress hormones in assessing the adequacy of general anesthesia for extensive surgical interventions for severe abdominal pathologies.

Material and Methods: The research was conducted on 92 patients who underwent severe and traumatic surgical operations due to various surgical pathologies of the abdominal cavity. Throughout the surgical procedure, the level of general anesthesia and consciousness was assessed using the BIS monitor, as well as other indicators and the state of miorelaxation based on the electromyographic (EMG) index of the frontal muscles.

Results: The research results were analyzed and evaluated in 3 stages: 1st - initial, preoperative; 2nd - the most traumatic, stressful moments of the operation, and finally - 30 minutes after the end of the operation.

Conclusion: Consequently, it is important to think that general anesthesia should be based on hemodynamic, metabolic data, BIS and EMG data as indicators of adequate anesthesia. Management of the adequacy of general anesthesia are based on hormonal indicators of a stressor, clinical assessment of ACTH, cortisol and other hormonal indications that may not be achieved at this particular time, i.e., during anesthesia, for the clinical evaluation of these hormones, cannot be considered acceptable due to delay.

Keywords: Anesthesia adequacy, BIS monitoring, stress hormones

INTRODUCTION

Neuroendocrine reactions resulting from surgical stress can occur through two major hormone secretion systems. These two systems are the hypothalamus - the pituitary gland - the adrenal glands and the sympathetic - adrenomedullary system. The first system includes the release of ACTH and cortisol, and the second - the release of norepinephrine from peripheral nerve endings and adrenaline from the cerebral cortex [1-4]. The main task for the anesthetist is to create optimal conditions for surgery and protect the patient from these neuroendocrine disorders [5-8].

The adequacy of the anesthesia performed can be evaluated based on various parameters of homeostasis, usually changes in the clinical, hormonal, neurophysiological and metabolic status [9-14]. These indicators constitute criteria for the adequacy of anesthesia. From hormonal indicators, ACTH and cortisol, as well as neurophysiological parameters, electroencephalogram monitoring (EEG) and BIS (bispectral index) [15-23], each of these have its own specific place and role in assessing the adequacy of general anesthesia [24,25].

Design

It was possible to study the role of monitoring BIS and stress hormones in assessing the adequacy of general anesthesia for extensive surgical interventions for severe abdominal pathologies.

MATERIAL AND METHODS

The research was conducted on 92 patients who underwent severe and traumatic surgical operations due to various surgical pathologies of the abdominal cavity in the Ministry of Health

DOI: 10.30546/azjcvs.2021.2.2.28

of the Republic of Azerbaijan, Scientific Surgery Center named after M.Topchubashov and Republican Hospital named after A.Heydarov of the Ministry of Internal Affairs. Patients aged 21–79 years, with an average height of 165.8±1.3 cm (152–182 cm), average weight of 77.7±3.0 kg (42–109 kg), 52 men (56.5%) and 40 women (43.5%).

The following surgical operations were performed on the patients: gastrectomy - 7 (7.6%); thoracoscopic resection of the esophagus - 10 (10.9%); pancreatoduodenal resection (PDR) - 5 (5.4%); gastric resection by Bilrots II method - 17 (18.4%); anterior resection of the rectum with insertion of a sigmoid rectal anastomosis - 8 (8.7%); hemicolectomy - 9 (9.8); resection of sigmoid colon with transverso-recto anastomosis - 9 (9.8%); extrusion of the rectum with the formation of anus preternaturalis - 2 (2.2%); total colectomy with the creation of three ileostomas - 4 (4.4%) and 21 (22.8%) other operations.

52 out of the 92 patients (56.5%) identified the following secondary pathologies: hypertension - 18 (19.6%); II - III grade obesity - 5 (5.4%); type II diabetes mellitus - 12 (13.0%); mitral valve disease - 3 (3.3%). In addition, 4 patients (4.5%) were found to have hepatitis “C” and 6 patients had cachexia.

The research results were analyzed and evaluated in 3 stages: 1st - initial, preoperative; 2nd - the most traumatic, stressful moments of the operation, and 3rd - 30 minutes after the end of the operation.

Hemodynamic parameters included monitoring of systolic (SAP), diastolic (DAP), mean (MAP) and pulse blood pressure (PAP), central venous pressure (CVP) and heart rate (HR), as well as continuous monitoring of the percentage of oxygen in arterial blood. From these indicators, it means arterial pressure was directly determined by the Hackelman formula, which allows one to evaluate tissue perfusion levels. Pulse pressure was calculated using the formula PAP=SAP - DAP and was taken into account when determining the volume of infusion therapy in combination with other hemodynamic parameters (CVP, HR, etc.).

Throughout the surgical procedure, the level of general anesthesia and consciousness was assessed using the BIS monitor (bispectral index), as well as other indicators and the state of miorelaxation based on the electromyographic (EMG) index of the frontal muscles.

The general somatic status of patients corresponded to risk level III-IV with ASA classification. Patients who underwent endotracheal anesthesia in combination with an epidural component are first injected with 500-800 ml of crystalloid solution in one of the peripheral veins. Under local anesthesia (0.5% novocaine solution), the epidural cavity was identified and catheterized according to the principle based on the loss of fluid resistance in the syringe. The end of the epidural catheter is placed at the level of the VI-VII during operations on the upper floor of the abdominal cavity and at the level of the VIII-IX during operations on organs in the middle and lower regions.

As a test dose, 10-15 mg of 0.5% marcaine or napropine was added to the epidural cavity. After 4-5 minutes, that is, after confirming that the epidural catheter is in the epidural cavity, induction for anesthesia begins. Afterwards anesthesia, against the background of hemodynamic stability, the main dose of local anesthetics (40-60 mg, i.e. 5-7.5 mg per spinal segment) was injected into the epidural cavity. During the operation, repeated doses of 10-20 mg local anesthetics were used. Standard premedication for patients (evening tranquilizers per.os 1 hour before taking the induction of anesthesia, benzodiazepines + opioid analgesics + antihistamines are injected into the muscles). Cholinolytics were administered intravenously according to instructions. One of the central veins (subclavian vein or internal jugular vein) for all patients were catheterized.

For the induction of anesthesia we used dimedrol 10-20 mg, dormicum (5-10 mg) or diazepam (10mg), opioid analgesics (morphine 10 mg or omnopon 20mg) , for curarization pipecuronium-bromide (arduan) 0.05-0.06 mg/kg, ketamine (calipsol) 2.5-3 mg / kg or thiopental-Na 2.5-3 mg /kg.

The patient had endotracheal intubation and connected to artificial respiration apparatus (AR). Normal mode of ventilation FiO_2=0.4-0.5, mechanical ventilation was performed on forced mode. As hypnotics and analgesic components of general anesthesia were used isoflurane in sub- doses, ketamine or thiopental-Na, fentanyl. All operations were performed as planned after the patients underwent preoperative preparation. Changes in homeostasis (hypovolemia, hypoalbuminemia, water exchange, QTM and other disorders) as a result of basic and related pathologies during surgical preparation have been adjusted.

On the operating table, before the induction of anesthesia, after sedation, patients were connected to the Ascept BIS monitor. BIS monitoring was continued throughout the operation and anesthesia. The level of anesthesia was rated as adequate when the BIS monitor rate was 40-60%, over 60% superficial anesthesia, under 40% there was a deep anesthesia. BIS monitor below 40% was considered dangerous and was not allowed. During general anesthesia, EMG was at a level of 30-80 dB, which indicates an adequate level of miorelaxation.

RESULTS

In a normal concentration, ACTH in the blood was taken as 9-63.3 pg/ml. As shown in Table 1, the concentration of ACTH at stage 1 was 89.05±3.24 pg/ml, which is 1.41 times higher than the upper limit of normal. This can be explained by the fact that, despite adequate care for the patient, the preoperative stress factor was not completely eliminated. The level of ACTH in stage 2 increased to 211.44 ±20.31 pg / ml, which was 2.37 times higher (t_1=6.7) than in stage 1. During the most traumatic period of the operation, other indicators, such as hemodynamic indicators, BIS monitors and EMG readings, indicate that anesthesia is adequate, but the level of ACTH is 3.33 times higher than normal. A very important principle should be noted here. Thus, you should not try to maintain the level of ACTH in the blood at a normal level during the traumatic period of the operation. Achieving this goal may be through the use of large doses of anesthetics and analgesics, only these high doses increases anesthetic aggression, increases the anesthesia risk, may cause hemodynamic, metabolic and other disorders. As shown in table 2, AKTH levels decreased to 71.72±2.39 pg/ml in phase III, which is 1.24 times higher than in phase I (t1=7.6), compared with phase II 2.95 times (t1=7.1) less.

Table 1. Stage-dependent dynamics of hormone levels in patients (n=18)

Indicators	Phases		
	I	II	III
ACTH (pg/ml)	89.05±3.24 (65-112.1)	211.44±20.31* (102-363)	71.72±2.39 (53-90.6)
Cortizol (n/mol/l)	714.79±44.86 (538-1254)	1230.92±72.45** (955-1876)	675.87±65.08* (169-1000)

Statistical accuracy of differences between these indica- tors:*p<0.05; **p<0.01

Normalization of the hormonal background can be explained by the fact that 30 minutes after the end of the operation, the level of surgical stress is reduced to a minimum and the patient is still in a state of analgesia, before and after anesthesia. During this period, i.e. stage 3, hemodynamic parameters within normal limits, BIS monitor indicators also show more than 80% that the patient is now in the awakening phase, at the same time, EMG indicators show the disappearance of the miorelaxation phase.

The concentration of cortisol in the blood was taken at the level of 171-536 nmol/l. At the first stage of the study, the concentration of cortisol in the blood was 714.79±44.86 nmol/l. In phase 2, the level of cortisol in the blood increased to 1230.92±72.45 nmol/l, which was 1.72 times higher than in phase 1 (t1 =13.8). In phase 3, the concentration of cortisol decreased to 675.87±65.08 nmol/l, which was 1.06 times (t1=0.8) compared with phase 1 and 1.82 times (t1=10.1) compared to phase 2 (p<0.05).

When we look at the gradual dynamics of cortisol levels in the blood, we see that it is the same as changes in ACTH.

Table 2 shows the step-by-step estimates of the BIS and EMG indicators.

Table 2. Dynamics of BIS and EMG indicators (n=57)

Indicators	Phases		
	I	II	III
BIS	95.95±0.48	52.02±0.14	96.07±0.12**
EMG	28.24±1.01	20.18±2.01	29.14±1.08*

Statistical accuracy of differences between indicators: compared to phase II - *p<0.05; **p<0.01

After premedication, EMG in the I phase was 28.24±1.01. In the II stage, i.e. as a result of exposure to muscle relaxants during general anesthesia EMG decreased to 20.18± 2.01 and turned out to be statistically more accurate, which is 1.4 times less (t1= 8.2) than phase I. In Phase III, EMG increased to 29.14±1.08, which was 1.44 times more than the II phase (t2=2.0), this also indicates that the effect of muscle relaxants at the end of the operation is over (p <0.01).

The nature of the correlations of the levels of stress hormones in the blood with indicators of BIS and EMG are shown in table 3.

Table 3. Correlation of hormones with indicators of BIS and EMG (n=57)

Indicators	Phases	
	ACTH	Cortizole
I	↓+**/↑+	↓+ /↑+
II	↓↓++ /↑↑+	↓↑+ / ↓↓ ++
III	↓+ /↓+	↓++ /↓ +

Character of the correlation: r<0,3 (+) weak; 0.3<r<0,7 (++)- medium; r<0.7 (+++)- strong. ↑- straight; ↓-inverse. * p<0.05; **p<0.01

Phase I between ACTH and BIS (r =-0.07; t=3,0; p<0.01), between prolactin and EMG (r=-0.04; t =1.3; p<0.05), there is the opposite weak correlation, which is statistically correct (Figure 1).

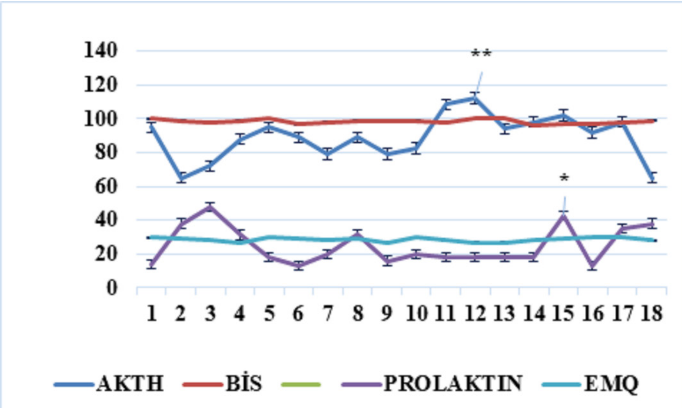

Figure 1. Correlative relationships between ACTH, prolac- tin, BIS and EMG

*Statistical accuracy of differences between indica- tors:*p<0.05; **p<0.01*

DISCUSSION

Therefore, it is important to think that general anesthesia should be based on hemodynamic, metabolic data, BIS and EMG data as indicators of adequate anesthesia. Management of the adequacy of general anesthesia based on hormonal indicators of a stressor, clinical assessment of ACTH, cortisol and other hormonal indications that may not be achieved at this particular time, i.e., during anesthesia, for the clinical evaluation of these hormones,

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cannot be considered acceptable due to delay.

CONCLUSION

In conclusion, the approach to assessing the adequacy of general anesthesia should be of two directions: scientific-clinical and practical-clinical. The dynamics of the level of stress hormones in the blood (ACTH, cortisol) and catecholamines is of great scientific-clinical importance. From a practical point of view, the assessment of the adequacy of general anesthesia during surgery should be based on dynamic changes in clinical, BIS monitoring, hemodynamics, ventilation, and metabolic homeostasis. These indicators should be evaluated comprehensively and should determine the course of general anesthesia. The acquisition of hormonal and some metabolic parameters requires a certain time, therefore, they have more scientific- clinical significance.

Considering that the components of anesthesia include loss of consciousness, amnesia, analgesia, lack of activity and weakening of the reaction of the autonomic nervous system to damaging stimuli and stressors (not a complete drop), but to a lesser extent), then this approach becomes fully justified.

Conflict of Interests: The author declares that there are no conflict of interests.

Financial Disclosure: There are no financial supports.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Study Association: This study is not associated with any thesis or dissertation work.

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