INFLUENCE OF THE DYNAMICS OF PERFUSION INDEX AS A CRITERION THE EFFICIENCY OF THE BLOOD CIRCULATION ON THE RESPONSE OF THE BODY OF OBESOUS PATIENTS TO SURGICAL STRESS DURING LAPAROSCOPIC CHOLECYSTECTOMY USING DIFFERENT METHODS OF ANESTHESIA

Summary. Objective. To evaluate the energy efficiency of blood circulation in different variants of anaesthetic support during laparoscopic cholecystectomy based on the study of correlations between the perfusion index in dynamics and the level of adaptation of the body to surgical stress.

Material and Methods. We examined 84 patients with grade II obesity with acute cholecystitis. The effectiveness of the proposed methods of anaesthetic support was evaluated in a cohort prospective randomised simple open clinical trial. The control points were premedication, induction, intubation, CO$_2$ insufflation, CO$_2$ desufflation, extubation, 3 hours after the end of the operation. The average age of the patients (women) was (58.4±6.1) years, and the level of surgical risk according to ASA was grade II. Patients were divided into 2 groups: Group I, 42 patients, who received total intravenous anaesthesia based on propofol through a perfuser and fentanyl; Group II, 42 patients, inhalation anaesthesia based on sevoflurane using a low-flow method and fentanyl. The effectiveness of anaesthetic protection was assessed by determining the correlation between the perfusion index and the level of adaptation of the body to surgical stress.

Results and discussion. The study showed that in patients of group II, where the method of anaesthetic support in patients with a high body mass index (obesity of the second degree) during laparoscopic cholecystectomy was a combination of sevoflurane and fentanyl, statistically significant correlations were determined between the perfusion index in the dynamics and the level of adaptation to surgical stress. In patients of group II, at the time of intubation, a strong positive correlation (r=0.87) was determined between the level of perfusion index and the state of adaptation, which depends, according to the calculation formula, on hemodynamic parameters, namely heart rate, systolic and diastolic blood pressure. A similar relationship was determined in patients of group II at the control point — CO$_2$ insufflation, r=0.84, CO$_2$ desufflation, r=0.82, at the time of extubation, r=0.62 and 3 hours after surgery, r=0.78.

Conclusions. In patients with a high body mass index, metabolic features impose certain conditions for the choice of anaesthetic support. During laparoscopic surgery, it is important to maintain normal tissue perfusion, especially in obese patients, which is the key to preventing postoperative complications. The perfusion index as an indicator of the ratio between pulsating and non-pulsating vessels of the capillary network has statistically significant correlations with the level of adaptation to surgical stress when using sevoflurane as the main component of general anaesthesia in obese patients undergoing laparoscopic surgery.

Key words: energy efficiency of blood circulation, perfusion index, increased body mass index, adaptation to operative stress, laparoscopic cholecystectomy, abdominal cavity, operations, anesthesia, propofol, sevoflurane.
Introduction

The microcirculatory channel has long attracted the attention of researchers, because it is in this area of the cardiovascular system that the most important process takes place - the exchange of substances between blood and tissues. An important and, in most cases, decisive characteristic of the state of microcirculation is the perfusion index - the ratio between pulsating and non-pulsating vessels of the capillary network. It indirectly characterizes the state of cardiac output and the balance between the sympathetic and parasympathetic nervous systems and can be an additional diagnostic tool that allows objectifying the state of peripheral blood flow [1, 2, 3].

The level of the perfusion index reflects the state of volumetric capillary blood flow, which depends on the state of cardiac output, vascular tone, and the volume of circulating vascular fluid. Stressful effects associated with an increase in the activity of the sympathetic nervous system, heart weakness, vascular insufficiency combined with a decrease in cardiac output, hypovolemia makes low the perfusion index. Perfusion improves in conditions of sympathetic blockade, stabilization of hemodynamics against the background of increased systemic blood pressure, elimination of intravascular fluid deficiency, increase in cardiac output, which is combined with vasodilation [4-7].

Thus, the perfusion index is an additional diagnostic tool that allows you to objectify the state of peripheral blood flow and timely use other diagnostic measures and means of intensive therapy to improve the patient’s condition.

Despite the high technical support of operative interventions, successes in anesthesiology and pharmacology, one of the most significant goals of surgery — performing an operation without stress, pain and risk — has not yet been achieved. Patients with an increased body mass index deserve special attention [5-9], as obesity leads to an increase in the total blood volume and ejection fraction, which is partly a consequence of an increase in body weight and increased activity of metabolic processes [10]. As a result, with obesity, the workload on the myocardium is always higher than in non-obese people. Often, an increase in the volume of intravascular fluid, an increase in the ejection fraction, myocardial hypertrophy, left ventricular diastolic dysfunction, and myocardiopathies lead to perioperative complications and an atypical reaction to operative stress [11-15].

The purpose of the study was to evaluate the energy efficiency of blood circulation in various options of anesthetic support during laparoscopic cholecystectomy based on the study of correlations of the perfusion index in dynamics with the level of adaptation of the organism to operative stress.

Material and methods

A comprehensive dynamic examination of 84 patients with obesity of the II degree, who underwent laparoscopic cholecystectomy as planned in the surgical department of the communal non-commercial entrepreneurial regional clinical hospital of the Kharkiv City Council, Kharkiv, and who were divided into 2 groups: Group I, 42 patients who underwent total intravenous anesthesia on based on propofol through a perfusor and fentanyl; Group II, 42 patients, inhalation anesthesia based on sevoflurane using the low-flow method and fentanyl. Control of the depth of anesthesia was carried out according to BIS indicators - the target depth of anesthesia was 60.

The average age of patients (women) was (58.4±6.1) years, the level of operative risk according to ASA was II degree. All patients were randomized according to anthropometric and gender indicators, duration of surgery and anesthesia, initial somatic status: average body weight was (98.6±8.2) kg, average height (168.2±9.6) cm, average body mass index (37, ±1.8), the average duration of anesthesia was 49.32.6 min, the average Charlson comorbidity index was (1.6±0.2) (survival prognosis after surgery is high, >90%).

Control points were premedication, induction, intubation, insufflation of CO₂, desufflation of CO₂, extubation, 3 hours after the end of the operation.

The perfusion index was measured by the photoplethysmographic method with a Masimo monitor using a compact portable sensor, where the reference values were its numbers in the range of 4-5%.

To determine the reaction of the patients’ body to operational stress, the state of adaptation of the body was determined on the basis of hemodynamic indicators - mean arterial pressure, heart rate.

The level of adaptation (AP) was determined by the formula of R.M. Baevsky. in the modification of Berseneva A.P. (1987, 1997):

\[
AP = 0.011 \times HR + 0.014 \times SBP + \frac{+ 0.008 \times DBP + \frac{+ 0.014 \times age (years)}{+ 0.009 \times body weight (kg)} - \frac{0.009 \times height (cm)}{0.27}}
\]

where: HR — heart rate per minute;
SBP — systolic blood pressure (mmHg);
DBP — diastolic blood pressure (mmHg).

The level of adaptation ≤ 2.1 characterized its satisfactory state, 2.11 - 3.2 - indicated the stress of adaptation, 3.21 - 4.3 - characterized unsatisfactory adaptation, > 4.3 - failure of adaptation.

The correlation coefficient (r) was determined to determine correlations between the studied indicators.
Research results

The study showed that in patients of group II, where the method of anesthetic support in patients with an increased body mass index (obesity of the II degree) during laparoscopic cholecystectomy was a combination of sevoflurane and fentanyl, statistically significant correlations were determined between the indicators of the perfusion index in dynamics and the rate of adaptation to operational stress (table 1).

Table 1

<table>
<thead>
<tr>
<th>perfusion index</th>
<th>Correlation coefficient (r)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>I group (n=42, X ±m)</td>
</tr>
<tr>
<td>premedication</td>
<td>0.42</td>
</tr>
<tr>
<td>induction</td>
<td>0.44</td>
</tr>
<tr>
<td>intubation</td>
<td>0.32</td>
</tr>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt; insufflation</td>
<td>0.34</td>
</tr>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt; desufflation</td>
<td>0.31</td>
</tr>
<tr>
<td>extubation</td>
<td>0.46</td>
</tr>
<tr>
<td>3 hours after surgery</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Thus, in group II patients at the time of intubation, a strong positive correlation, r=0.87, was determined between the level of the perfusion index and the rate of adaptation, which depends, according to the formula, on hemodynamic indicators, namely heart rate, systolic and diastolic arterial pressure. A similar correlation was determined in patients of group II at the control point - insufflation of CO<sub>2</sub>, r=0.84, desufflation of CO<sub>2</sub>, r=0.82, at the time of extubation, r=0.62 and 3 hours after surgery, r=0.78.

In patients of group I, on the contrary, during intubation, insufflation and desufflation of CO<sub>2</sub> between the determined level of the perfusion index and the state of adaptation to operational stress, there was a significant low positive correlation, r=0.32, r=0.34 and r=0.31, respectively. The low correlation in patients with an increased body mass index (obesity of the II degree) during laparoscopic cholecystectomy with the method of anesthetic support with the use of propofol and fentanyl is justified by the unstable results of measuring the perfusion index in real time, which indicates low tissue perfusion and, in turn, by a greater difference in the amount of light received by the photoreceptor in different phases of the cardiac cycle.

Taking into account the obtained data, it can be determined that the low correlation between tissue perfusion and the level of adaptation to operative stress during general anesthesia with propofol in patients undergoing laparoscopic operations indicates in favor of its possible negative effect on hemodynamics in obesity.

Conclusions

1. In patients with an increased body mass index, the peculiarities of metabolism put forward certain conditions for choosing a method of anesthetic support.
2. During laparoscopic operations, it is important to maintain normal tissue perfusion, especially in obese patients, which is the key to preventing postoperative complications.
3. The perfusion index as an indicator of the ratio between pulsating and non-pulsating vessels of the capillary network has statistically significant correlations with the level of adaptation to operative stress when using sevoflurane as the main component of general anesthesia in obese patients during laparoscopic operations.

REFERENCES


Реферат. Мета. Оцінка енергетичної ефективності кровообігу при різних варіантах анестезіологічного забезпечення при лапароскопічній холецистектомії на підставі дослідження кореляційних зв’язків показника перфузійного індексу в динаміці з рівнем адаптації організму до операційного стресу.

Матеріал і методи. Обстежено 84 хворих з ожирінням II ступеня і з гострим холециститом. Проведена оцінка ефективності запропонованих методів анестезіологічного забезпечення в процесі когортного проспективного рандомізованого простого відкритого клінічного дослідження. Точками контролю були премедикація, індукація, інтубація, інсуфляція СО₂, десуфляція СО₂, екстубація, через 3 години після закінчення операції. Середній вік пацієнтів (жінки) був 58,4±6,1 років, рівень операційного ризику за ASA був II ступеня. Пацієнти були розподілені на 2 групи: І група, 42 пацієнта, яким проводилася тотальна внутрішньовенна анестезія на основі пропофолу через перфузор та фентанілу; ІІ група, 42 пацієнта, інгаляційна анестезія на основі севофлюрану методом низького потоку та фентанілу. Оцінку ефективності анестезіологічного захисту проводили визначенням кореляції між перфузійним індексом та рівнем адаптації організму до операційного стресу.

Результати та їх обговорення. Дослідження показало, що у пацієнтів групи ІІ, де методом анестезіологічного забезпечення у пацієнтів з підвищеним індексом маси тіла (ожиріння II ступеня) при лапароскопічній холецистектомії була комбінація севофлюрану та фентанілу, були визначені статистично значущі кореляційні зв’язки сміж показниками перфузійного індексу в динаміці і рівнем адаптації до операційного стресу. У пацієнтів групи ІІ в момент інтубації був визначений сильний позитивний зв’язок, r=0,87, між рівнем перфузійного індексу і станом адаптації, який залежить, згідно формулі розрахунку, від показників гемодинаміки, а саме частоти серцевих скорочень, систолічного і діастолічного артеріального тиску. Аналогічний зв’язок був визначений у пацієнтів групи ІІ в точці контролю - інсуфляція СО₂, r=0,84, десуфляція СО₂, r=0,82, в момент екстубації, r=0,62 і через 3 години після операції, r=0,78.

Висновки. У пацієнтів з підвищеним індексом маси тіла особливості метаболізму висувають певні умови до вибору методу анестезіологічного забезпечення. При лапароскопічних операціях важливим є збереження нормальної перфузії тканей, особливо у пацієнтів з ожирінням, що є запорукою профілактики післяопераційних ускладнень. Перфузійний індекс як показник співвідношення між пульсуючими та непульсуючими судинами капілярної мережі має статистично значущі кореляційні зв’язки з рівнем адаптації до операційного стресу при використанні севофлюрану як основного компонента загальної анестезії у пацієнтів з ожирінням при проведенні лапароскопічних операцій.

Ключові слова: енергетична ефективність кровообігу, перфузійний індекс, підвищений індекс маси тіла, лапароскопічна холецystектомія, черева порожнина, операції, анестезія, пропофол, севофлюран.