OPTIMUM VALUE OF MAC DURING HALOTHANE INHALATION ANAESTHESIA

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Abstract

Background: Uptake of inhalation anesthetics may be measured as the amount of anesthetic infused to maintain a constant alveolar concentration of anesthetic with halothane. We converted the values to those that would be obtained at 1.2 minimum alveolar concentrations (MAC). Inhalational anaesthesia is a result of gas delivery in the body by the respiratory tract in order to induce loss of normal sensation (anaesthesia). An important concept in the comparison of inhalational anaesthetics is the measurement of potency known as MAC of the anaesthetic substance.

Patients and methods: 50 patients (mean age 47.4 ±7.9 years) ASA I and II were scheduled for elective general surgery. The first thirty minutes of the operation, all the patients were treated with halothane at 1.2 MAC value and mean blood pressure and heart rate were monitored. The second thirty minutes of the operation, halothane at 2 MAC value was used and the same monitoring of clinical parameters followed.

After the sixtieth minute till the end of the operation all the patients were treated with halothane at 1.2 MAC value.

Results: There is a significant difference concerning mean arterial pressure in time depending on halothane MAC values (p=0,001), and a good correlation was also found between MAC values and mean blood pressure of r=0,612, p=0, 02. while no correlation was found between halothane end tidal and heart rate of r=0,054, p=0, 651

Conclusion: Optimum value of MAC during halothane inhalational anaesthesia corresponding to optimal blood pressure was 1.2.

Keys words: MAC, inhalational anaesthesia, mean arterial pressure, heart rate.

Introduction

Inhalational anaesthesia is a result of gas delivery in the body by the respiratory tract in order to induce loss of normal sensation (anaesthesia). During absorption and delivery, some portions of anaesthetic agents are present, which eventually results in loss of sensation.

An important concept in the comparison of inhalational anaesthetics is the measurement of potency known as MAC (minimal alveolar concentration) of the anaesthetic substance.

Clinical measurement of the depth of anaesthesia has already been discussed to have originated directly from the patient and to have disclosed the normal physiological response to be measured and used in practice. The best evaluator of anaesthetic potency is MAC (1,2,3,4,8,9,11,13).

Minimal alveolar concentration is analogous to the computerized values of ED50 according to the respective curve of the pharmacological dose. In this way the potency of different inhalational agents can be compared (12). Although the use of MAC in comparing the potency of various anaesthetics has been criticized, it is nowadays widely used (14).

MAC is the minimal alveolar concentration of the anaesthetic substance per atmosphere, which prevents the move to some fifty percent degree of the subjects responding to the painful stimulus. MAC reflects the partial pressure of anaesthesia in the brain (Pbr) as the partial alveolar pressure (Pa) is in equilibrium with the brain. One halothane MAC corresponds to 0.77% concentration of halothane. Clinically speaking, it is necessary to use MAC at 1.2-1.3 in order to prevent the move in 95% of the patients (1, 2, 4, 5, 9).

Various physiological and pharmacological factors influence MAC (1,2,3,4,8,9). The object of the study is the optimal value of MAC during halothane inhalational anaesthesia and the relation between alveolar concentration of the inhaled anaesthetic as well as the clinical indications for the assessment of the depth of anaesthesia. Blood pressure and heart rate are the main signs used in clinical practice to clinically evaluate the depth of anaesthesia.

Patients and methods

The research is of prospective type. Fifty ASA I and II patients were selected for the study to undergo elective surgery at the General and Digestive Surgical Service near the First Clinic of Genral Surgery. The sample of the population was non-randomized at all. The selection of the patients was made following the below-mentioned criteria:

Age 30-50 years
Elective surgery
No cardiovascular disease
No pulmonary disease
No disturbances of acid-base metabolism
First operation
Normal body
Duration of operation, over 70 minutes

All the patients had been premedicated with 10 mg oral diazepam in the morning of the operation.

The values of the systolic and diastolic blood pressure for each patient were automatically monitored by a blood pressure monitor every five minutes from the moment the patient was lying on the operation table.

Each patient's systolic and diastolic blood pressure and heart rate were monitored by Lifespace monitor; halothane Fi, concentration, halothane end tidal and MAC were estimated by Capnomac UltimaTM (Figure nr.1).

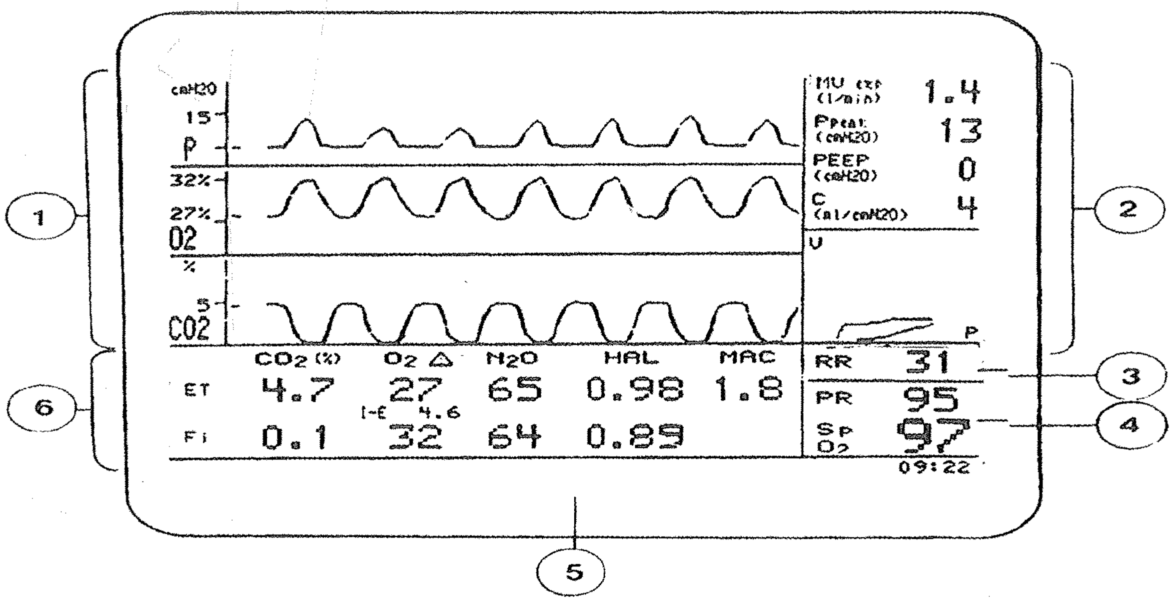

Figure nr.1. Capnomac UltimaTM

The induction of anaesthesia was performed by means of thiopental 6mg/kg, fentanyl 5 micrograms/kg, suxamethonium 1,5 mg/kg. Anaesthesia was maintained by assisted ventilation of open circuit with a tidal volume of 10ml/kg, respiratory rate of 12/min with 4l/O2 and 6 l of air, fentanyl 2 micrograms/kg every 30 minutes, 100 micrograms/kg of pancuronium as bolus and 10-12 micrograms/kg every 45 minutes as maintenance dose. Inhalational anaesthesia was carried out with halothane. After induction patients were ventilated until MAC value reached 1.2. The operation started at this value.

The first thirty minutes of the operation all the patients were treated with halothane at 1.2 MAC value and mean blood pressure and heart rate were monitored. The second thirty minutes of the operation halothane at 2 MAC value was used and the same monitoring of clinical parameters followed.

After the sixtieth minute till the end of the operation all the patients were treated with halothane at 1.2 MAC value.

The assessed clinical parameters are as follows:

Mean arterial pressure, which was figured up by using the following formula

$$\text{Mean arterial pressure} = \frac{\text{systolic pressure} + 2\ \text{diastolic pressure}}{3}$$

Heart rate on the Capnomac Ultima TM monitor, MAC, FI and ET halothane values were registered. MAC values are empiric; they are not absolute values. The MAC values on the Capnomac Ultima TM monitor correspond to healthy adult values and do not apply to children. Age and other individual factors are not measured by this monitor.

ET halothane values correspond to its end tidal, whereas FI parameter corresponds to partial halothane concentration in the inspired gas.

We are studied the values of arterial pressure and heart rate before anaesthetic induction, during the first sixty minutes of anaesthesia before the beginning of the incision, analyzing them every 10 minutes as well as the MAC halothane values by analyzing them every 30 minutes.

Statistical analysis: For constant variables, values were introduced as mean values ± standard deviation, whereas for categorical variables the data were reported in percentage.

The student's pair test was applied for the comparison of constant variables. The relation between phenomena was analyzed by means of the Pearson correlation quotient. Values of p d" 0.05 (or 5%) were judged as significant. ANOVA method was employed as well.

Results

The group of fifty sample patients was made up of twenty-nine females (58%) and twenty-one males (42%) aged 47.4 ± 7,9 years on average (Figure nr 2).

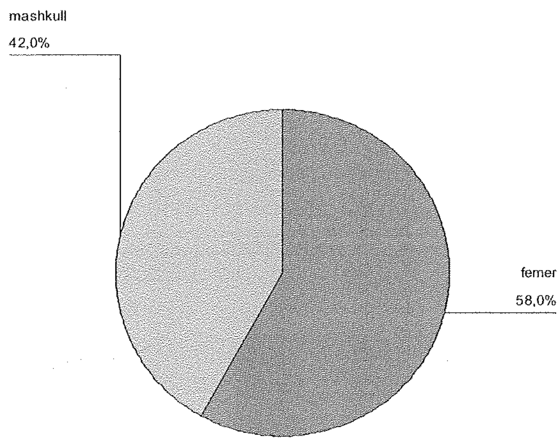

Figure nr. 2 . Sex of patients

Patients were divided according to the pathologies represented in table nr.1 (Table nr.1).

Table nr.1. The pathology of patients

Nr.	Diseases	Frequency	Percentage
1.	Nodular thyroid gland	17	34
2.	Calculose cholecystitis	15	30
3.	Ventricle cancer	4	8
4.	Umbilical hernia	4	8
5.	Incisional hernia	3	6
6.	Colon cancer	2	4
7.	Abdominalcist	2	4
8.	Intestinalocclusion	1	2
9.	Inguinalhernia	1	2
10.	Appendicitis	1	2
	TOTAL	50	100

The following table (Table nr.2) shows that there is a significant difference concerning mean arterial pressure in time depending on halothane MAC values. p* is considered significant at p d" 5% (Table nr. 2).

Table nr.2. Dates of blood pressure

Pairs	Mean	Standard deviations	p*
Systolic pressure 10-60	19,6944	9,5073	0,001
Diastolic pressure 10-60	12,2778	6,8059	0,001
Mean pressure 10-60	14,8611	5,5660	0,001
FR 10-60	,6111	2,4989	0,151 N.S.

An interesting fact is that a correlation was found between end tidal quantity and arterial pressure of r = 0,5, p = 0.01, while no correlation was found between halothane end tidal and heart rate of r = 0,054, p = 0, 651 (Table nr. 3).

Table nr.3. The changes of clinical parameters before and during the operation

	the changes of clinical parameters before and during the operation											
	before surgery				on surgery							
	heart rate	DS	mean arteril pressure	DS	heart rate			DS	mean arterial pressure			DS
					measure I	measure II	measure3		measure I	measure II	measure3	
MAC 1.2	86.36	2.5	101.06	5.566	79.46	78.86	78.8	2.56	95.04	92.96	95.38	5.5
	P>0.05		P<0.05		P>0.05				P<0.05			
MAC 2	86.36	2.5	101.06	5.566	78.48	78.56	78.92	2.56	83.22	82.18	79.76	5.5
	P>0.05		P<0.05		P>0.05				P<0.05			

The following figure show that when MAC values increase, heart rate remains constant (0, 151 N.S.) (Figure nr.3).

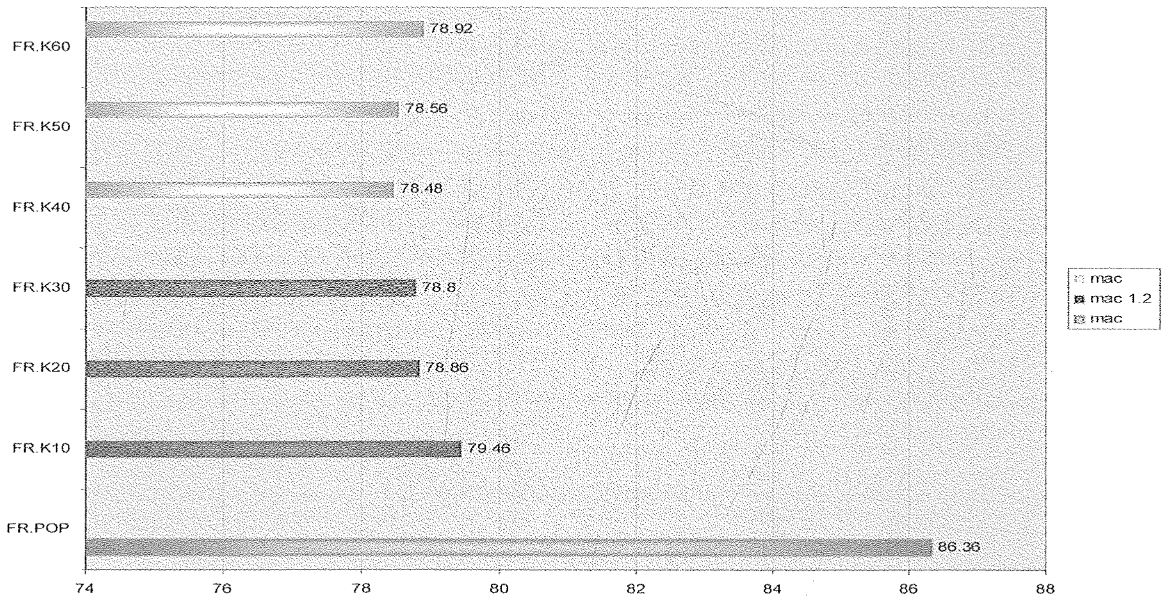

Figure nr.3. Correlation between Mac and heart rate

A good correlation was also found between MAC values and mean blood pressure of r = 0, 612, p = 0, 02 (Figure nr.4).

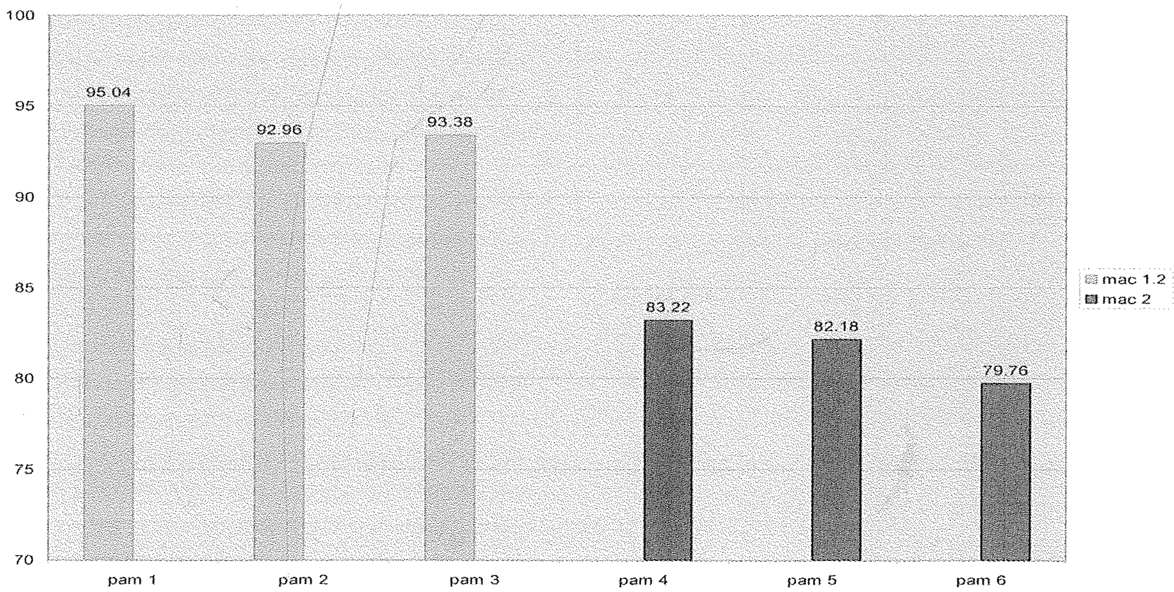

Figure nr.4. Correlation between Mac and blood pressure

We can see and in graphic way blood pressure values in halothane anaesthesia for sixty minutes (Figure nr.5).

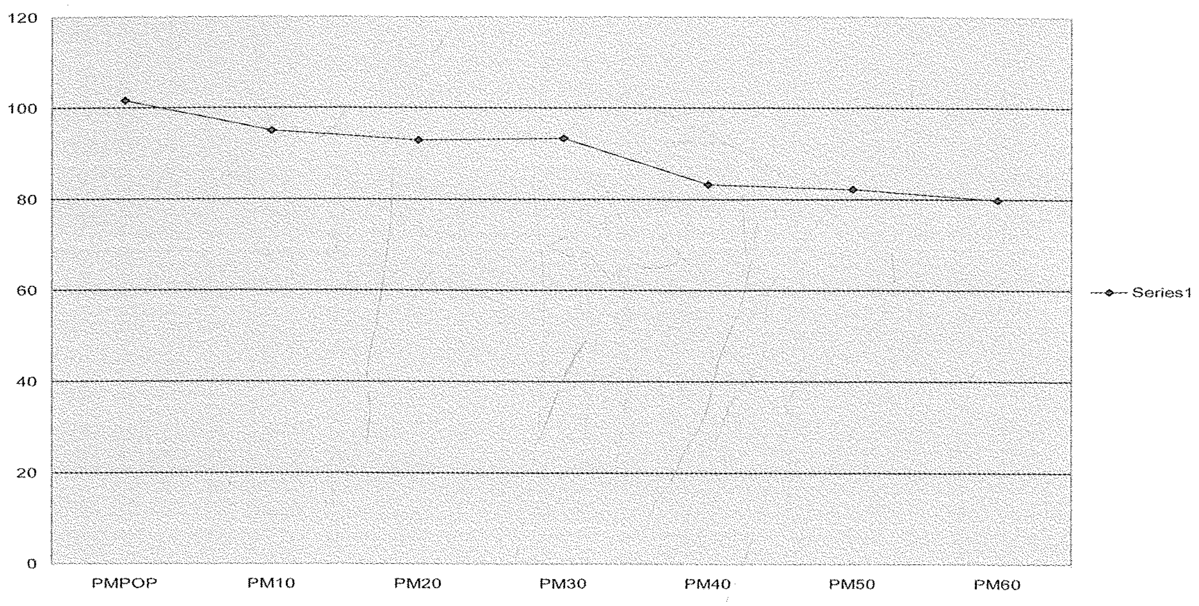

Figure nr.5. Blood pressure values in halothane anaesthesia for sixty minutes

Mean blood pressure changes in relation to halothane MAC values (Figure nr.6).

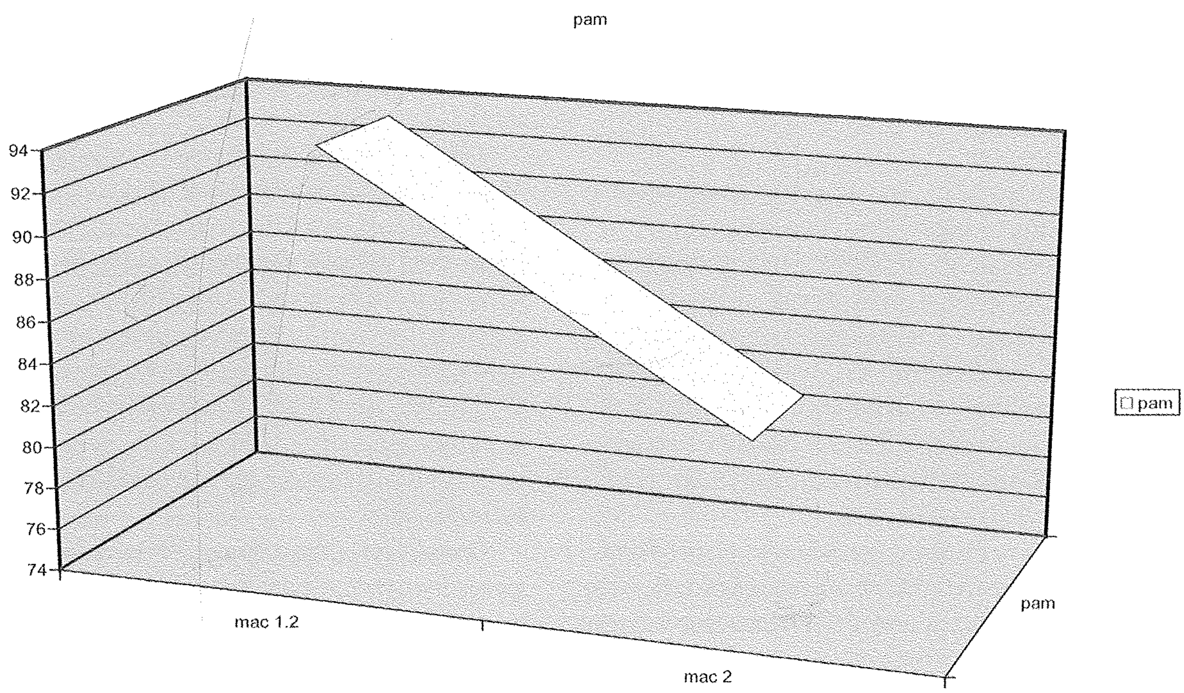

Figure nr.6. Mean blood pressure changes in relation to halothane MAC values

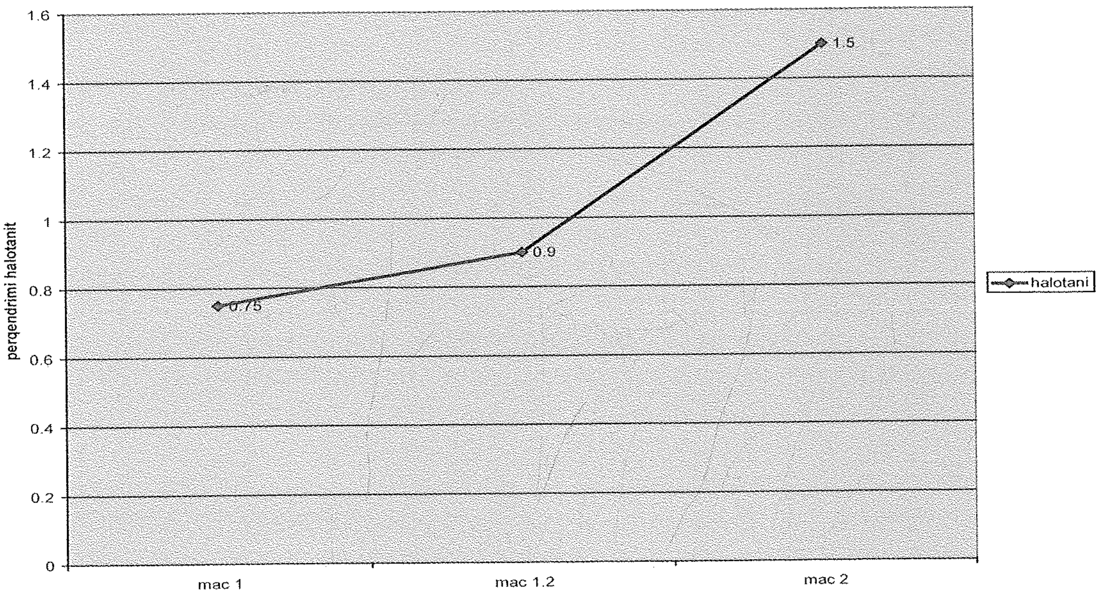

Figure nr.7 The optimal MAC of 1.2 value has a corresponding 0.9% value of halothane concentration

The above graphic shows (Figure nr.7), that optimal MAC of 1.2 value has a corresponding 0.9% value of halothane concentration.

When halothane concentration increases, MAC values do as well.

Discussion

The use of MAC to measure anaesthetic potency has two great advantages (11).

First, it is a highly productive measurement, constant in a great number of species.

Second, the use of end tidal concentration of gases provides an index of "free" concentration of substances that produce anaesthesia, because there is balance between end tidal concentration of gases and "free" concentration in plasma.

The many clinical measurements of little or insignificant effect when scientifically evaluated (blood pressure or pulse) have been carried out in centres of clinical discussions over the depth of anaesthesia in everyday practice (1,2,3,9,14).

In this study we have attempted to give a modest contribution to the definition of optimal MAC values in halothane inhalational anaesthesia based on clinical parameters such as arterial pressure and heart rate, criteria, which apply to other authors as well (1,2,8,9,10,15,16).

The decrease in mean blood pressure is the most widely used indication of the increase in the depth of halothane anaesthesia (1,3).

This finding was estimated even in our study.

Clinical evaluation was carried out after MAC values settled at 1.2 and at this point skin incision commenced in order to obtain more real values of mean blood pressure and heart rate. The measurements were taken during the first hour of the intervention by using thirty-minute halothane anaesthesia of 1, 2 MAC and thirty-minute halothane anaesthesia of 2,0 MAC and mean blood pressure and heart rate were estimated every ten minutes.

It was noted that for 1,2 MAC values corre sponding to 0,9% halothane concentration, mean blood pressure value was 94.46, whereas for 2 MAC values corre sponding to 1,5% halothane concentration, mean blood pressure value was 81.72. The decrease in mean blood pressure was about 15%, a value comparable to other authors as well.

Heart rate was a poor relative indicator. The achieved result demonstrates that heart rate remained at 79. 04 at 1.2 MAC and at

78.66 at 2 MAC and the difference was insignificant p = 0.651 (1,2,3,10).

In conclusion, it was noted that optimal MAC values for halothane inhalational anaesthesia corresponding to optimal blood pressure was 1.2 and it complied with the literature data (1,2,3,4,6,7,8,9,11,13).

For the first hour of halothane anaesthesia, the decrease in mean blood pressure is the only accessible clinical indicator of anaesthetic depth: hence, the increase in halothane concentration causes progressive decrease in arterial blood pressure, while heart rate remains constant, results which correspond to those provided in the literature (1,2,3). Clinically speaking, it is indispensable to set MAC at 1.2 -1.3 in order to prevent the movements in 95% of the patients (9). This result was estimated even in the above study.

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