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Hemodynamic indicators in pregnant women with obesity of various degrees of expression

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Summary

Purpose: To study indicators of central and peripheral hemodynamics in pregnant women with obesity of varying severity at a gestational age of 36-38 weeks.

Materials and Methods: To study hemodynamic parameters (heart rate, SDD, UI, SI, OPSS, CR, LVMI) in pregnant women with obesity of varying severity, 127 pregnant women (I, main group) aged from 23 to 34 years were selected obesity of varying severity with gestational age 36-38 weeks. The second (control) group consisted of 28 pregnant women of the same age and gestational age with normal body weight (body mass index from 19 to 24.9 kg / m2). The groups were identical in age, gestational age, which allowed for an objective and comparative assessment.

Results: At a gestational age of 36-38 weeks, hemodynamic parameters in women with normal body weight (BMI - 19-24.9 kg / m2) corresponded to the standards characteristic of healthy pregnant women of this gestational age. All women had an eukinetic type of blood circulation, RR was 1.15 ± 0.03 conventional units, LVMI - 0.59 ± 0.005 W × m2. RR corresponded to 18.4 ± 1.3 per minute, SpO2 - 97.7 ± 0.58%, hourly urine output - 0.80 ± 0.12 ml / kg / h, which indicates effective oxygenation and a completely satisfactory state of peripheral circulation , renal excretory function. An increase in BMI to 40 or more kg / m2 (morbid obesity of the III degree) contributed to the progression of signs of heart failure, which manifested itself in a significant decrease in one-

time and minute cardiac output, CR, LVMI; increased heart rate; increased myocardial oxygen demand; decrease in hourly urine output. There was a hypokinetic circulation. Against this background, severe tachycardia was observed (heart rate - 93.7 ± 2.8 per minute). SDI and UPVS increased relative to the group of pregnant women with normal weight, respectively by 28.7% and 91.7%. DP was 14.5 ± 0.12 conventional units, which indicates a high myocardial oxygen demand. There was tachypnea (RR - 25.8 ± 0.2 per minute) and low blood oxygen saturation (SpO2 - 92.6 ± 0.6%).

Conclusion: An increase in body mass index to 40 or more kg / m2 contributes to the progression of signs of heart failure, which requires an individual approach to prenatal preparation, the choice of timing, method of delivery and the method of anesthesia.

Key words: pregnancy, hemodynamics, obesity.

1. Introduction

WHO considers obesity as an epidemic affecting over 300 million people and continuing to grow steadily among women, reaching 25-30%. Overweight and obesity account for 5% of the world's total deaths (WHO, 2010). In economically developed countries, the incidence of obesity in pregnant women is 35-38%. The number of people suffering from obesity is growing rapidly, and by 2025 it may reach 1,000,000,000 [1; 2]. Overweight and obesity are defined by WHO (2011) as abnormal and excess body fat that can be harmful to health.

There are the following main forms of obesity:

- exchange-alimentary (exogenous-constitutional) - the most common;
- cerebral;
- endocrine exchange.

In recent decades, among the population of industrialized countries, the percentage of obesity has increased at a high rate. In Europe and the United States, the problem of obesity is becoming threatening [3; 4; 5]. In Russia, over 50% suffer from obesity, and up to 4-8% of the adult population suffer from its severe forms. Accordingly, the number of pregnant women with morbid obesity is increasing [6; 7; 8]. Obesity during pregnancy complicates the management of this category of patients - this is associated with an increase in the number of complications such as gestational hypertension, preeclampsia, gestational diabetes and an increase in the frequency of emergency caesarean sections [9; 10; 11].

The presence of morbid obesity also creates significant difficulties in carrying out anesthesia. Obesity, a high percentage of comorbidities, the urgency of surgery and

general anesthesia are factors leading to anesthetic complications with maternal mortality. Confidential Inquiries into Maternal Deaths in the United Kingdom reported that 35% of women who died were obese, compared with an overall obesity rate of less than 17% in the general pregnancy population. Maternal mortality was primarily associated with aspiration during induction, aspiration pneumonitis, and ineffective resuscitation after hemodynamic collapse. Resuscitation in pregnant women with morbid obesity is more difficult and less effective than in patients with normal weight.

Both pregnancy and obesity lead to numerous physiological changes in a woman's body. These effects mutually potentiate, which leads to a decrease in the functional reserve, systemic disorders, which significantly increases the obstetric and anesthetic risks.

It is well known that excess body weight during pregnancy, as it progresses, leads to dysfunctions of the main life support systems, and primarily of the cardiovascular system: the volume of circulating blood increases; preload increases due to increased blood volume; cardiac output increases in proportion to the degree of obesity (every 100 grams of stored fat increases cardiac output by 30-50 ml / min); with obesity, a hyperdynamic type of blood circulation often develops, hypertrophy of the left atrium, left ventricle and interventricular septum; increased vascular resistance, including the pulmonary arteries, leading to systolic and diastolic dysfunction; dilated cardiomyopathy; patients with morbid obesity in 5-10% of cases have high hypertension (for every 10 kg of excess weight, the systolic pressure rises by 3-4 mm Hg, and the diastolic pressure by 2 mm Hg); with circulatory hypoxia, hemo-concentration increases, manifested by an increase in hematocrit; due to varicose veins, the volume of the epidural space decreases; an increase in the incidence of varicose veins of the pelvic organs and lower extremities [12].

It should also be noted that obese pregnant women represent a group of increased risk for the development of preeclampsia, since the leading role in the occurrence of this pathology is assigned to disorders of macro- and micro-hemocirculation [13; 14; 15]. In this regard, the study of hemodynamic parameters in obese pregnant women is of particular importance in terms of preparing for delivery, determining the direction of drug treatment, and choosing a rational method of anesthesia. The following changes in the cardiovascular system are of particular importance for the anesthesiologist: arrhythmias associated with fatty degeneration of the myocardium; myocardial ischemia against the background of an increase in its oxygen demand and a decrease in oxygen delivery; heart failure, increasing with prolonged obesity; in the supine position there is a very high risk of developing

aorto-caval compression syndrome, especially in conditions of sympathetic blockade against the background of regional anesthesia; the risk of injury to the veins of the epidural space during puncture and catheterization; high hemo-concentration (with a hematocrit over 40 and hemoglobin over 140 g / l) causes a violation of tissue perfusion, exacerbating tissue hypoxia; high venous pressure (obesity + pregnancy) and varicose veins are risk factors for thromboembolic complications [16; 17].

2. Material and research methods

To study hemodynamic parameters in pregnant women with obesity of varying severity, 127 pregnant women (I, main group) aged 23 to 34 years with obesity of varying severity with gestational age 36-38 weeks were selected. The second (control) group consisted of 28 pregnant women of the same age and gestational age with normal body weight (body mass index from 19 to 24.9 kg / m2). The groups were identical in age, gestational age, which allowed for an objective and comparative assessment.

Pregnant women of the main group were divided into 4 subgroups depending on the degree of obesity. The patients we observed had a normal pregnancy, without complications according to the consultations of obstetricians and gynecologists.

The degree of obesity was determined by the Quetelet body mass index (BMI) BMI = weight (kg): {height (m)} 2. According to BMI, pregnant women in the main group were distributed as follows: in 32 pregnant women, it ranged from 25 to 29.9 kg / m2 (overweight) - I subgroup; in 33 - from 30 to 34.9 kg / m2 (I degree of obesity) - II subgroup; in 32 - from 35 to 39.9 kg / m2 (II degree of obesity) - III subgroup; at 30 - ≥40 kg / m2 (3rd degree of obesity) - IV-th subgroup.

Central hemodynamics was studied by echocardiography using the ACCUVIXQX Medison apparatus (Japan). Stroke (SI) and cardiac index (SI), specific peripheral vascular resistance (UPVR), left ventricular power index (LVMI), reserve ratio (CR) were calculated [5; 6; 11].

The types of central hemodynamics were differentiated as hyperkinetic, eukinetic and hypokinetic.

Blood pressure (BP), heart rate (HR), respiration rate (RR), blood oxygen saturation (SpO2) were monitored using a Schiller-argus monitor (Sweden). Calculated mean dynamic pressure (SDP) and myocardial oxygen demand, which was assessed by the double product (DP) = APsysthHR / 1000, taking 8-12 conventional units as the norm. [eleven]. The hourly urine output was also studied, calculating it from the daily amount of excreted urine.

All numerical values obtained during the study were processed by the method of variation statistics using the Student's test (using Microsoft Office Excel programs) and presented as M ± m, where M is the arithmetic mean, m is the standard error. Differences were considered statistically significant at P <0.05. The results are presented in the table.

3. Results

As can be seen from the table, with a gestational age of 36-38 weeks, hemodynamic parameters in women with normal body weight (BMI - 19-24.9 kg / m2) corresponded to the standards characteristic of healthy pregnant women of this gestational age [13; 15]. All women had an eukinetic type of blood circulation, RR was 1.15 ± 0.03 conventional units, LVMI - 0.59 ± 0.005 W × m2. RR corresponded to 18.4 ± 1.3 per minute, SpO2 - 97.7 ± 0.58%, hourly urine output - 0.80 ± 0.12 ml / kg / h, which indicates effective oxygenation and a completely satisfactory state of peripheral circulation , renal excretory function.

An increase in BMI to 25-29.9 kg / m2 at the same gestational age provoked moderate hemodynamic disturbances - a significant decrease in one-time and minute heart rate, LVMI and CR, respectively, by 16.1%, 11.4%, 6.7% and 17.4%. DP increased from 7.9 ± 0.13 to 9.2 ± 0.11 conventional units, which indicates an increase in myocardial oxygen demand. At the same time, the eukinetic regime of blood circulation, adequate diuresis and blood oxygen saturation remained.

Comparing the results obtained with the corresponding indicators in patients with normal weight, we can conclude that overweight provokes a number of pathological processes leading to moderately expressed violations of the functional parameters of the cardiovascular system, a decrease in the productivity of the myocardium. At the same time, there are no signs of heart failure.

An increase in BMI up to 30-34.9 kg / m2 (obesity of the 1st degree) was accompanied by a significant increase in heart rate by 12.1% in relation to the group of pregnant women with normal weight, an increase in SDI and UPVS by 13.2% and 38.7, respectively. %, as well as a decrease in MI, CI, CR and LVMI by 27.3%, 19.4%, 27.9% and 11.2%, respectively. DP increased to 11.3 ± 0.7 conventional units, hourly urine output remained at stable numbers, without significantly changing. Against this background, the RR increased significantly to 25.4 ± 0.5 per minute with a simultaneous decrease in SpO2 to 96.0 ± 0.7%.

Comparing the obtained results of the 2nd subgroup with overweight pregnant women (the 1st subgroup), we also noted a progressive decrease in SI, SI, CR, LVMI with a simultaneous increase in PSR and LF (see Table 1).

An increase in BMI to 35-39.9 kg / m2 (obesity of the II degree) was accompanied by a significant decrease relative to normal body weight; MI, SI, CR, LVMI by 37.4%, 29.8%, 37.6% and 18.8%, respectively, which indicates the formation of heart failure. At the same time, SDD, UPSS, DP increased by 23.4%, 74.3%, 73%; HR and HR increased by 15.6% and 28%. SpO2 corresponded to 93.6 ± 0.5%, hourly urine output 0.62 ± 0.03 ml / kg / hour.

There was a clear tendency for the transition of the eukinetic regime of blood circulation to the hypokinetic one.

It should be noted that almost all the parameters we studied, characterizing the functional state of the cardiovascular system, significantly differed from the II subgroup of pregnant women with grade I obesity (BMI 30.0-34.9 kg / m2) with a clear tendency to deterioration. (see Table 1.).

An increase in BMI to 40 or more kg / m2 (morbid obesity of the III degree) contributed to the progression of signs of heart failure, which manifested itself in a significant decrease in one-time and minute cardiac output, CR, LVMI; increased heart rate; increased myocardial oxygen demand; decrease in hourly urine output (see table 1). There was a hypokinetic circulation. Against this background, severe tachycardia was observed (heart rate - 93.7 ± 2.8 per minute). SDI and UPVS increased relative to the group of pregnant women with normal weight, respectively by 28.7% and 91.7%. DP was 14.5 ± 0.12 conventional units, which indicates a high myocardial oxygen demand. There was tachypnea (RR - 25.8 ± 0.2 per minute) and low blood oxygen saturation (SpO2 - 92.6 ± 0.6%).

Table # 1.

Some indicators of the circulatory system and respiratory function in pregnant women with normal, overweight and obesity at a gestational age of 36-38 weeks.

Studied indicators	II (control) group (n = 28)	I (main) group, (n = 84)			
		I subgroup (n=32)	II subgroup (n = 33)	III subgroup (n = 32)	IV subgroup (n = 30)
Heart rate, in minutes	76,4±2,4	82,2±2,1	85,6±1,5Δ	88,3±1,6Δ	93,7±2,8*Δ
SDD, mm Hg	81,3±2,7	85,6±2,2	92,0±2,5Δ	100,3±2,2*Δ	104,6±2,6Δ
UI, ml / m2	42,4±2,2	35,8±0,5Δ	30,6±0,3*Δ	26,5±0,4*Δ	23,7±0,14*Δ
SI, l / m2 / min	3,3±0,15	2,92±0,09Δ	2,66±0,05 *Δ	2,31±0,06*Δ	2,16±0,03*Δ
UPSS, dyn × s / cm5 / m2	722,3±39,6	879,2±30,2	1001,8±35,0 *Δ	1258,9±43,6*Δ	1384,6±37,3*Δ
KR, conventional units	1,15±0,03	0,95±0,04Δ	0,83±0,03 *Δ	0,71±0,03* Δ	0,66±0,03Δ
LVMI, W × m2	0,59±0,005	0,55±0,006Δ	0,52±0,006*Δ	0,48±0,006*Δ	0,46±0,007Δ

DP, conventional units	7,9±0,13	9,2±0,11Δ	11,3±0,7*Δ	13,7±0,12*Δ	14,5±0,12*Δ
BH, per minute	18,4±1,3	22,0±0,4Δ	23,5±0,4Δ	24,0±0,5Δ	25,8±0,2Δ
SpO2,%	97,7±0,58	97,1±0,6	95,4±0,4Δ	93,8±0,5Δ	92,6±0,6Δ
Hourly urine output, ml / kg / hour	0,80±0,12	0,74±0,11	0,72±0,08	0,62±0,03Δ	0,60±0,07Δ

Note: Δ - reliability of differences ($p < 0.05$) relative to the group of pregnant women with normal body weight;
* - reliability of differences ($p < 0.05$) relative to the previous group of pregnant women with a lower BMI.

4. Discussion

The foregoing allows us to conclude that overweight, as it progresses, has an extremely unfavorable effect on hemodynamics and the functional state of the cardiovascular system as a whole. The most pronounced violations of the functional parameters of the cardiovascular system occur in obesity of the II and III degrees. In this contingent of women, even with uncomplicated pregnancy, by the gestational age of 36-38 weeks, heart failure is formed, a hypokinetic regime of blood circulation, requiring an individual approach to prenatal drug preparation, timing and method of delivery, methods of anesthesia.

5. Conclusions

An increase in the body mass index up to 39.9 kg / m2 in pregnant women of the main group is accompanied by a significant decrease, relative to pregnant women with normal body weight, stroke index, cardiac index, reserve coefficient, left ventricular power index, which indicates a decrease in one-time and minute heart performance. the formation of heart failure.

An increase in body mass index up to 40 or more kg / m2 contributes to the progression of signs of heart failure, which requires an individual approach to prenatal preparation, the choice of timing, method of delivery and the method of anesthesia.

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