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Study and evaluation of the functional state of the maternal and fetal circulatory systems at the time of delivery in patients with mitral stenosis

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Abstract---It is established that the severity of functional disturbances in the maternal and fetal circulatory systems is directly related to the degree of mitral stenosis (MS) and terms of gestation. 76 women aged 18-28 years old with MS of different severity were examined at gestational periods from 12-14 to 36-38 weeks. Depending on the degree of MS all patients were divided into IV groups. We used A. N. Okorokov's classification. N Okorokov's classification was used. We distinguished "insignificant" MS with the area of 2.9 cm², "moderately expressed" (2.9-2.0 cm²), "expressed" (1.9-1.1 cm²), and "critical" MS. (1cm²). The studies were performed immediately before the presumed termination of pregnancy. The main parameters of hemodynamics and uterine-placental-foetal blood flow were studied. The most expressed disorders, dangerous in terms of hemodynamic catastrophes, were registered in women with "severe"

and "critical" MI, which were formed by 32-34 (III g) and by 12-14 (IV g) weeks of gestation, respectively. Minimal abnormalities occurred in patients with "negligible" and "moderately expressed" MS at gestational terms of 36-38 and 34-36 weeks, respectively.

Keywords---pregnancy, circulatory system, mitral stenosis.

Introduction

Ensuring hemodynamic stability during pregnancy and delivery in patients with mitral stenosis (MS) is one of the most important tasks for the group of specialists ensuring safe delivery. It is the functional state of maternal and fetal circulatory systems. In this category of patients the obstetric and anesthesiological tactics helps to choose the optimal terms and variants of delivery, the most sparing methods of anesthesia aid. The leading role is played by the severity of MI and the associated functional disorders of the maternal and fetal circulatory systems that progress with increasing gestational age and limiting circulatory reserves. The literature variously indicates the presence of compromised blood flow in pregnant women with MS with increasing gestational age. However, the severity of these changes and their relationship with uteroplacental fetal blood flow depending on the degree of MS at different gestational ages has not been adequately addressed. Therefore, the aim of the present study was to investigate in detail the functional state of the maternal cardiovascular system and uteroplacental-fetal blood flow by the estimated delivery date depending on the severity of mitral stenosis.

Materials and methods: 76 women with MS of varying severity aged 18 to 28 years at gestational ages from 12-14 to 36-38 weeks were studied. We used A.N. Okorokov's classification, 9 allocating "insignificant" MS with a total area of stenosis >2.9 cm², "moderately severe" (2.9-2 cm²), "severe" (1.9-1.1 cm²), and "critical" (<1 cm²). All examined women were monitored by an obstetrician-gynecologist and a cardiologist and received appropriate cardiac therapy (cardioprotectors, antioxidants, antihypoxants, etc.).

Depending on the severity of MI and gestational age at the time of expected delivery (termination of pregnancy), all patients were divided into 4 groups. (19 cases in each group).

Group I included patients with "insignificant" MS; Group II included patients with "moderately severe" MS; Group III included women with "severe" MS; Group IV included patients with "critical" MS.

Delivery (termination of pregnancy) was performed according to the existing protocol based on obstetric indications and the functional state of the circulatory system at that time.

Group I patients at 36-38 weeks gestation, Group II patients at 34-36 weeks, Group III patients at 32-34 weeks, and Group IV patients at 10-12 weeks. The studies were performed routinely 2 to 3 days before the expected delivery. (termination of pregnancy).

Hemodynamics was studied by echocardiography. We studied UI, SI, PPS and reserve coefficient (RC). Simultaneously heart rate (HR) in min, mean dynamic pressure (MDP), respiratory rate (RR), ECG and SpO₂ in % were recorded using a monitor. Heart failure (CH) was qualified according to N.V. Strazhesko, V.S. Vasilenko, as well as according to the New York classification (NYHA). The diagnosis of CH was made after consultations with cardiologists and cardiac surgeons.

At the same time, the functional state of uterine-placental-fetal blood flow (MFPF) was investigated by Dopplerometry in the same population of women. The functional state of MFPB was judged by the resistance index (IR) of the left and right uterine arteries and umbilical artery. The systolic-diastolic ratio (SDR) in the fetal middle cerebral artery was also studied. The data obtained are presented in the table. All numerical values obtained during the study were processed by variance statistics using Student's criterion using Microsoft Excel software and presented as $M \pm m$, where M is the arithmetic mean and m is the standard error. Differences at $P < 0.05$ were considered statistically significant.

Results and Discussion: The results obtained (Table) allowed a quite satisfactory state of central hemodynamics to be established in Group I pregnant women (MS2.9 cm²), which fell within the normodynamic blood circulation regime (Table1), which allowed prolongation of pregnancy. The HR in this category of patients was 0.88 ± 0.03

Table1.
Some MPTC indices in pregnant women with mitral stenosis by the time of delivery of termination of pregnancy

Study groups degree of MS severity gestational age				
The studied indicators	Group I Minor MS (36-38 weeks) n=19	Group II Moderate MI (34-36 weeks) n=19	Group III Severe MI (32-34 weeks) n=17	Group IV Critical MS (12-14 weeks) n=19
HR, beats per min	92,5±2,6	99,7±2,3Δ®	113,9±3,9Δ○	98,4±1,6□
BP, mm Hg.	80,4±3,3	84,1±2,2Δ®	82,3±2,1Δ○	82,7±3,1□
UI, ml/m ²	33,7±2,8	26,7±1,7Δ®	17,4±1,6Δ○	22,6±1,5□
SI, l/m ² /min	3,08±0,06	2,58±0,04Δ®	1,92±0,08Δ○	2,2±0,08□
OPPS, dyne×s.-×cm.	1365,4±48,6	1754,3±52,7Δ®	2021,7±62,1Δ○	1875,1±87,6□
CfR	0,88±0,03	0,71±0,08Δ®	0,64±0,02Δ○	0,61±0,04□
Left uterine artery (DI)	0,61±0,012	0,8±0,013Δ®	0,91±0,012Δ○	0,83±0,01□
Right uterine artery (RI)	0,62±0,014	0,78±0,011Δ®	0,9±0,01Δ○	0,82±0,012□
Umbilical artery (UA)	0,59±0,013	0,74±0,012Δ®	0,86±0,011Δ○	0,89±0,012□
Middle cerebral artery (MCA)	9,6±0,014	13,7±0,012Δ®	17,4±0,03Δ○	-
Note: ® - significance of differences (P<0.05) between groups I and II; Δ - significance of differences				

($P < 0.05$) between groups II and III; $\circ$ - significance of differences ($P < 0.05$) between groups I and III; $\square$ - significance of differences ($P < 0.05$) between groups I and IV;

The study of the MPPC in this category of patients did not reveal any pronounced pathological abnormalities (Table 2).

Thus, the absence of marked maternal and fetal circulatory system pathology in pregnant women with minor MI during gestation allows us to equate them to relatively healthy laborers, and to the minimum risk group.

Group II pregnant women ($MS-2.9-2\text{cm}^2$) at 34-36 weeks' gestational age had moderately severe hemodynamic insufficiency in the form of marked tachycardia, decreased instant and minute cardiac output, and increased ROSS (see Table); CR was 0.71 ± 0.08 . On the whole, hemodynamic state was in hypodynamic circulation mode (see table).

On this background we recorded a slight decrease of the studied indexes of MBPK relative to the proper values in practically healthy pregnant women during the same gestational period. (Table).

Thus, by 34-36 weeks of gestation, patients with "moderately expressed" MI begin to form hemodynamic insufficiency, which can be classified as CH degree I (II-III class according to NYHA), which is logically reflected in the functional state of IPPC. Being aware of the fact of further progression of CH as the gestational age increases, one should think about the feasibility (safety) of further prolongation of pregnancy in this category of patients in favor of an early delivery.

In women of Group III ($MI-1.9-1.1\text{ cm}^2$), already at gestational terms of 32-34 weeks, all signs of IIA class CH (III phase according to NYHA) were registered, and IU and SI decreased to critical values (see Table). The HR was 0.64 ± 0.05 . On the whole, hypodynamic circulation mode took place. The aforementioned parameters indicate the impending hemodynamic catastrophe, ruling out further prolongation of pregnancy. Accordingly, the indices characterizing the functional state of the MFPC worsened sharply (see Table), which indicates the formation of a pronounced fetoplacental insufficiency, putting the fetus at risk (fetal death).

Thus, gross abnormalities in the functional state of the cardiovascular system in patients with severe MI do not allow to prolong pregnancy beyond 32-34 weeks and require timely correction and an exclusively abdominal delivery option in a specialized obstetric institution. There are doubts about the appropriateness of pregnancy in general in this category of patients. In all likelihood, pregnancy is allowed only after cardiac surgical correction. Already at gestational ages of 12-16 weeks, Group IV women ($MS\ 1\text{cm}^2$) registered all clinical and functional signs of CH IIA class (III-IV class according to NYHA) with concomitant marked impairment of IPPC (see Table), KF was 0.64 ± 0.03 . The above pathological changes allow recommending immediate termination of pregnancy with subsequent cardiac correction.

Conclusions

1. The severity of functional impairment in maternal and fetal circulation is directly related to the degree of mitral stenosis and gestational age.
2. Minimal abnormalities of hemodynamics and MSCC occurred in the patients with "negligible" and "moderately severe" MI at gestational ages of 36-38 and 34-36 weeks, respectively.

The most marked and dangerous violations in terms of hemodynamic catastrophe were observed in women with "severe" and "critical" MI, which were formed by 32-34 (III-group) and 12-14 (IV-group) weeks of gestation, respectively, and were subject to emergency abdominal delivery (III-group) or termination of pregnancy (IV-group).

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