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PREDICTORS OF THE DEVELOPMENT OF CARDIAC ARRHYTHMIAS IN WOMEN AFTER INDUCTION OF SUPEROVULATION *IN VITRO* FERTILIZATION

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The article presents the results of a clinical and instrumental examination of 80 healthy women (average age 32,31 ± 3,57 years) in order to assess the heart rhythm disturbances after induction of superovulation during *in vitro* fertilization. All women were examined twice – before and after induction of superovulation during extracorporeal fertilization. Clinical and instrumental examination included: electrocardiography at rest; echocardiography; 24-hour ECG monitoring with heart rate variability analysis; 24-hour blood pressure monitoring. Induction of superovulation is associated with a significant increase in mean daily HR max ($p < 0,01$), and consequently with an increase in myocardial oxygen demand. It has been established that induction of superovulation contributes to the development of supraventricular arrhythmias ($p < 0,01$) and an increase in episodes of apnea/hypnea ($p < 0,01$). Regression analysis revealed predictors of supraventricular arrhythmias after induction of superovulation, including adverse circadian heart rate profile, adverse circadian blood pressure profile, impaired autonomic regulation of heart activity ($p < 0,01$). It was shown that the appearance of rhythm disturbances is associated with both the initial functional state of the cardiovascular system and its response to the induction of superovulation. It was established a correlation between the estradiol concentration and the increase of daily average heart rate after induction of superovulation ($r = 0,30$, $p < 0,05$), apnea/hypnea index after induction of superovulation ($r = 0,34$, $p < 0,05$). Conclusion. Superovulation induction may exacerbate existing chronic cardiovascular diseases. Due to the adverse effect of superovulation induction on the daily heart rate profile, women need to evaluate the functional state of the cardiovascular system during *in vitro* fertilization planning. This will prepare the woman for the upcoming procedure and avoid adverse reactions from the cardiovascular system in response to stimulation of superovulation *in vitro* fertilization.

Keywords: women's health; extracorporeal fertilization; rhythm disturbances; risk of rhythm disturbances in women; induction of superovulation.

ПРЕДИКТОРЫ РАЗВИТИЯ НАРУШЕНИЙ СЕРДЕЧНОГО РИТМА У ЖЕНЩИН ПОСЛЕ ИНДУКЦИИ СУПЕРОВУЛЯЦИИ ПРИ ЭКСТРАКОРПОРАЛЬНОМ ОПЛОДОТВОРЕНИИ

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В статье представлены результаты клинико-инструментального обследования 80 практически здоровых женщин (средний возраст 32,31 ± 3,57 года) с целью оценки нарушений ритма сердца после индукции суперовуляции при экстракорпоральном оплодотворении. Все женщины обследовались дважды — до и после индукции суперовуляции при экстракорпоральном оплодотворении. Клинико-инструментальное обследование включало: электрокардиографию в покое; эхокардиографию; суточное мониторирование ЭКГ с анализом вариабельности сердечного ритма; суточное мониторирование артериального давления. Получены данные о том, что индукция суперовуляции ассоциируется со значимым повышением среднедневной частоты сердечных сокращений (ЧСС) max ($p < 0,01$), а следовательно и с увеличением потребности миокарда в кислороде. Установлено, что индукция суперовуляции способствует развитию суправентрикулярных нарушений ритма ($p < 0,01$) и учащению эпизодов апноэ/гипноэ ($p < 0,01$). Регрессионный анализ выявил предикторы развития суправентрикулярных нарушений ритма после индукции суперовуляции, в числе которых неблагоприятный суточный профиль ЧСС, неблагоприятный суточный профиль артериального давления, нарушение вегетативной регуляции сердечной деятельности ($p < 0,01$). Появление нарушений ритма ассоциировано как с исходным функциональным состоянием сердечно-сосудистой системы, так и с ее ответной реакцией на индукцию суперовуляции. Установлена корреляция между концентрацией эстрадиола

и повышением среднедневной ЧСС после индукции суперовуляции (r = 0,30, p < 0,05), индексом апноэ/гипноэ после индукции суперовуляции (r = 0,34, p < 0,05). Заключение. Индукция суперовуляции может способствовать обострению имеющихся хронических сердечно-сосудистых заболеваний. В связи с неблагоприятным влиянием индукции суперовуляции на суточный профиль ЧСС женщинам в период планирования экстракорпорального оплодотворения целесообразно проводить оценку функционального состояния кардиоваскулярной системы. Это позволит подготовить женщину к предстоящей процедуре и избежать неблагоприятных реакций со стороны сердечно-сосудистой системы в ответ на проведение стимуляции суперовуляции при экстракорпоральном оплодотворении.

Ключевые слова: здоровье женщин; экстракорпоральное оплодотворение; нарушения ритма; риск нарушений ритма у женщин; индукция суперовуляции.

About 186 million people around the world are infertile, and the occurrence of infertile couples is 15%–17% and tends to increase [5, 6]. At present, there are about 5 million childless families in Russia, and every fifth woman of reproductive age is not able to conceive a child spontaneously [4]. The incidence of female infertility in our country is 164 cases per 100,000 women [2]. In the period from 2001 to 2014, the number of infertile women increased 1.7 times. Over recent years, female infertility ranked first in the structure of reproductive losses [1].

Studies show that the inability to conceive is associated with cardiovascular risk, as many nonfertile women have cardiometabolic disorders that potentially increase the risk of cardiovascular disease [3, 12]. Moreover, some types of infertility are associated with an increased risk of cardiovascular diseases [7, 8, 10, 11].

The method of *in vitro* fertilization (IVF) provides a unique opportunity to implement the ability to give birth in almost all forms of female and many forms of male infertility [6]. Although IVF is considered a common and relatively safe method of treating infertility, the risk of side effects in the cardiovascular system still has to be taken into account [14]. Foreign studies have shown that hormonal therapy of infertility can predispose to cardiovascular diseases [9, 11, 13]. However, a small number of studies and their high heterogeneity cannot make firm conclusions about the safety of assisted reproductive technologies for the cardiovascular system. In Russia, this problem has almost not been studied. In this regard, studies aimed at assessing cardiovascular risk after applying hormonal regimens for the treatment of infertility in IVF are required.

This study aimed to perform a comparative assessment of cardiac rhythm disturbances according to daily ECG monitoring before and after superovulation induction in IVF.

MATERIAL AND METHODS

Eighty women (average age of 32.31 ± 3.57 years) were examined. All patients underwent an IVF procedure in the Center for Reproductive Technologies of the St. Petersburg City Mariinsky Hospital. An indication for IVF was a history of primary or secondary female/male infertility. Of patients, 21.3% had female infertility factor (n = 17), 37.5% had male infertility factor (n = 30), and 41.3% had mixed infertility factor (n = 33).

Criteria for inclusion in the study were reproductive age suitable for the IVF procedure (from 18 to 43 years), a history of primary or secondary female/male infertility, lack of IVF contraindications, and voluntary consent to participate in the study. The study did not include women with a history of cardiovascular or endocrine system diseases, as well as hormonal disorders.

- Ovulation induction was performed according to a short protocol that consisted of the following phases:
- From days 2 to 10 of the cycle, the recombinant human follicle-stimulating hormone Gonal-f (Italy) was administered at a dose of 300 IU.
- From days 7 to 11, the gonadotropin-releasing hormone antagonist Orgalutran (Netherlands) was administered subcutaneously at a dose of 0.25 mg.
- On day 11 at 23:00, the recombinant human chorionic gonadotropin Ovitrelle (Italy) was administered subcutaneously at a dose of 250 mcg.
- On day 11 at 23:00, a synthetic analog of the gonadotropin-releasing hormone Decapeptyl (Germany) was administered subcutaneously at a dose of 0.2 mg.
- On day 13, 36 h after the last injection, ovarian puncture was performed to obtain an oocyte.

According to the results of the one-way analysis of variance test, age did not affect the changes in daily ECG monitoring indicators (Fisher's test F = 0.92336, p = 0.53431); therefore, women were not divided into groups by age.

The study of the functional condition of the cardiovascular system was performed twice in a hospital: a day before the start of superovulation induction (day 1 of the cycle) and after completion of the superovulation induction (day 14).

Clinical and laboratory examination included a double study of the general and biochemical analysis of blood (alanine aminotransferase, aspartate aminotransferase, total protein, creatinine, urea, glucose, and total cholesterol), as well as hormonal studies with the determination of thyroid-stimulating hormone and estradiol levels before and after stimulation of superovulation in IVF. Venous blood was sampled for laboratory tests in the morning on an empty stomach. The concentration of total cholesterol, aspartate aminotransferase, alanine aminotransferase, glucose, creatinine, urea, and total protein was determined using an Architect c8000 biochemical analyzer (Abbot, USA). Estradiol concentration was determined in a Cobas e 411 immunochemical analyzer (Roche, Switzerland) using an Alkor-Bio reagent kit (St. Petersburg, Russia). The concentration of thyroid-stimulating hormone was determined using an Architect i2000 immunochemical analyzer (Abbot, USA). The results of clinical and instrumental examination before and after the superovulation induction are presented in Table 1.

The study was conducted using a portable cardiomonitor Kardiotechnika (Incart, St. Petersburg). The device was installed in the morning. Continuous ECG recording was performed under conditions of unlimited activities of daily living for 24 h.

Quantitative variables are presented as arithmetic mean ± standard deviation ($M \pm \sigma$) or confidence intervals (CIs). Categorical variables are presented as the frequency of detection and/or as percentage share. Hypothesis on the equality of two mean values for parametric data was tested using the Student *t*-test for dependent samples (when comparing the indicators over time). The differences were considered statistically significant at $p < 0.05$. To identify the relationship between quantitative accounting parameters, a correlation analysis was performed with the determination of the Pearson correlation coefficient (r). To identify the relationship between quality accounting parameters, the χ^2 criterion was determined. To identify the relationship between several parameters, a multiple regression analysis was performed with the step-by-step exclusion of variables. The multiple regression model included factors with a significant regression coefficient B ($p < 0.05$).

To determine the relative risk of adverse events (AEs), the patients were divided into two groups: those with the presence of an AE after superovulation induction and those who had no AE after superovulation

Table 1 / Таблица 1

Laboratory indicators before and after induction of superovulation
Лабораторные показатели до и после индукции суперовуляции

Parameters / Параметры	Before stimulation superovulation, $M \pm \sigma$ ($n = 80$) / До индукции суперовуляции, $M \pm \sigma$ ($n = 80$)	After stimulation of superovulation, $M \pm \sigma$ ($n = 80$) / После индукции суперовуляции, $M \pm \sigma$ ($n = 80$)	*p*
Total protein, g/l / Общий белок, г/л	74.63 ± 5.83	71.92 ± 5.69	<0.001
Creatinine, mmol/l / Креатинин, ммоль/л	72.98 ± 11.31	76.76 ± 10.54	<0.001
Urea, mmol/l / Мочевина, ммоль/л	4.79 ± 1.39	5.07 ± 1.47	<0.001
Cholesterol, mmol/l / Холестерин, ммоль/л	3.70 ± 0.80	4.18 ± 0.65	<0.001
Alanine aminotransferase, IU/l / Аланинаминотрансфераза, МЕ/л	19.01 ± 4.75	23.06 ± 4.79	<0.001
Aspartate aminotransferase, IU/l / Аспартатаминотрансфераза, МЕ/л	24.62 ± 16.55	26.37 ± 4.53	>0.05
Glucose, mmol/l / Глюкоза, ммоль/л	4.02 ± 0.52	4.44 ± 0.50	<0.05
Estradiol, pmol/l / Эстрадиол, пмоль/л	103.42 ± 12.18	907.92 ± 150.46	<0.001
Thyroid-stimulating hormone, mIU/ml / Тиреотропный гормон, мМЕ/мл	1.20 ± 0.47	2.47 ± 0.45	<0.001

induction. Using the four-field table, the relative risk of an AE was calculated, which was represented by the emergence of cardiac rhythm disturbances or episodes of apnea-hypopnea after superovulation induction:

$$\text{OP} = \frac{a / (a + b)}{c / (c + d)},$$

where *a* implies a risk factor and an adverse outcome, *b* means no risk factor with an adverse outcome, *c* implies a risk factor without an adverse outcome, and *d* means no risk factor without an adverse outcome.

The relative risk indicator was compared with 1 to determine the relationship of the factor with the outcome. When the value of the relative risk indicator is 1, it was concluded that the factor under study did not affect the probability of the outcome (lack of connection between the factor and the outcome). When the value of the relative risk indicator was more than 1, it was concluded that the factor increased the frequency of outcomes (direct correlation). When the value of the relative risk indicator was less than 1, a conclusion was drawn about a decrease in the probability of an outcome when exposed to a factor (feedback).

RESULTS AND DISCUSSION

An analysis of the results of daily ECG monitoring revealed the changes in the parameters of the heart rate (HR) daily profile after stimulation of superovulation compared with the baseline values. According to daily ECG monitoring conducted in women on day 1 after stimulation of superovulation, there was a slight but significant increase in the average daily ($p < 0.01$) and average night HR values ($p < 0.01$). The most pronounced increase was registered in the average daily HR max (111.8 ± 16.9 beats/min before and 124.7 ± 11.6 beats/min after; average increase in HR12.9 ± 7.3 beats/min; $p < 0.01$). The average daily HR values min (58.1 ± 5.4 beats/min before and 64.3 ± 6.6 beats/min after; average HR increase 6.2 ± 5.3 beats/min; $p < 0.01$) and average night HR indicators min (50.7 ± 4.4 beats/min before and 57.6 ± 6.5 beats/min after; an increase in HR6.9 ± 4.7 beats/min; $p < 0.01$) were found to be more stable (Table 2). A correlation was established between the concentration of estradiol and the increase in the average daily HR on day 1 after the superovulation induction ($r = 0.30$, $p < 0.05$).

After superovulation induction, a decrease in the circadian HR index was registered in female patients (1.18 ± 0.18 beats/min before and 1.12 ± 0.17 beats/min after; $p < 0.05$). Similar changes are usually registered with increased activity of the sympathetic part of the autonomic nervous system.

In 27.5% of women after the superovulation induction, the frequency of supraventricular extrasystole decreased, and in 57.5%, it increased compared with the baseline level. In 5.0%, supraventricular extrasystole was registered for the first time, and in 10.0%, its

Table 2 / Таблица 2

Dynamics of the daily profile of the heart rate in women before and after induction of superovulation during extracorporeal fertilization

Динамика суточного профиля частоты сердечных сокращений у женщин до и после индукции суперовуляции при ЭКО

Times of day / Время суток	Heart rate, beats/min / Показатель ЧСС, уд/мин	Before stimulation superovulation, $M \pm \sigma$ ($n = 80$) / До стимуляции суперовуляции, $M \pm \sigma$ ($n = 80$)	After stimulation of superovulation, $M \pm \sigma$ ($n = 80$) / После стимуляции суперовуляции, $M \pm \sigma$ ($n = 80$)	Difference, $M \pm \sigma$ / Разница, $M \pm \sigma$	*p*
Daytime / Дневное время	Heart rate minimal / ЧСС минимальная	58.1 ± 5.4	64.3 ± 6.6	6.2 ± 5.3	<0.01
	Heart rate average / ЧСС средняя	75.1 ± 5.9	83.1 ± 6.3	8.1 ± 5.2	<0.01
	Heart rate maximal / ЧСС максимальная	111.8 ± 16.9	124.7 ± 11.6	12.9 ± 7.3	<0.01
Night time / Ночное время	Heart rate minimal / ЧСС минимальная	50.7 ± 4.4	57.6 ± 6.5	6.9 ± 4.7	<0.01
	Heart rate average / ЧСС средняя	65.0 ± 9.0	75.6 ± 12.1	10.6 ± 7.4	<0.01
	Heart rate maximal / ЧСС максимальная	92.9 ± 13.0	103.3 ± 9.1	9.1 ± 6.1	<0.01

Note. HR – heart rate.
Примечание. ЧСС — частота сердечных сокращений.

frequency remained unchanged. Thus, in most female patients, an increase in the total number of supraventricular extrasystoles after induction of superovulation was noted ($p < 0.01$; Figure 1).

According to the data obtained, ventricular extrasystoles did not occur in the female patients examined both before and after stimulation of superovulation. There was an increase in the average number of supraventricular extrasystoles over time compared with the initial state (2.51 ± 1.61 extrasystoles per hour after before and 3.20 ± 2.95 extrasystoles per hour after; $p < 0.05$) and an increase in the average number of apnea-hypopnea episodes (0.23 ± 0.12 per hour before and 1.51 ± 0.81 per hour after; $p < 0.01$; Figure 2).

It should be noted that, in general, an uncritical amount of supraventricular extrasystoles was recorded both during the hour and during the day. This was also true for the apnea-hypopnea index, the values of which did not exceed the norm (up to 5 episodes per hour). In the female patients examined, episodes of apnea-hypopnea occurred only at night. A direct correlation was established between the estradiol concentration and the apnea-hypopnea index after superovulation induction ($r = 0.34$, $p < 0.05$). It was also revealed that the total number of supraventricular extrasystoles recorded per day correlates directly with the level of average daily HR ($r = 0.28$, $p < 0.05$, respectively). Therefore, the more significant the increase in the average daily HR is, the greater is the likelihood of supraventricular rhythm disturbances during the induction of superovulation in IVF. Thus, the data obtained in the study indicate that stimulation of superovulation with IVF can be a triggering factor for changes in the heart rhythm. The presence of a history of cardiovascular diseases in a woman may contribute to pathological changes in the heart rhythm. Female patients with cardiovascular pathology were not included in our study; therefore, no pathological number of supraventricular extrasystoles was registered after the induction of superovulation. However, according to the data obtained, the induction of superovulation is associated with an increase in the average daily HR max ($p < 0.01$) and, therefore, with an increase in myocardial oxygen demand. The above factors can contribute to the exacerbation of existing chronic cardiovascular diseases, as well as the development of heart rhythm disorders and more frequent episodes of apnea-hypopnea.

Before stimulation of superovulation, episodes of apnea-hypopnea were registered in 22.5% of female patients, and after manipulation, they were noted in 50.0% ($\chi^2 = 15.7$, $p < 0.01$; Figure 3).

It should be noted that after the induction of superovulation, 27.5% of female patients experienced episodes of apnea-hypopnea, 22.5% had more frequent episodes of apnea-hypopnea, and 50.0% had the baseline number of apnea-hypopnea episodes. In the subgroup of female patients in which episodes of apnea-hypopnea were recorded after the induction of superovulation compared with women without apnea-hypopnea, higher levels of estradiol (936.44 ± 114.94 and 817.59 ± 150.23 pmol/L, respectively; $p < 0.05$),

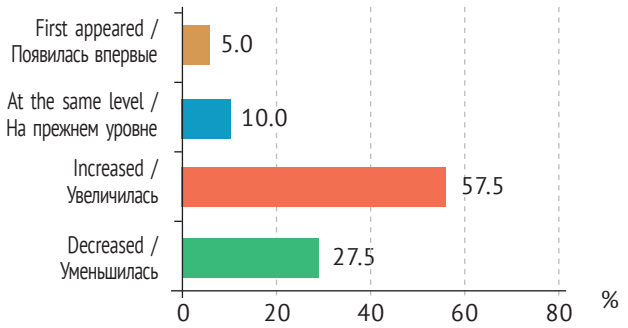

Fig. 1. Distribution of women in accordance with the dynamics of supraventricular extrasystole after induction of superovulation, %

Рис. 1. Распределение женщин в соответствии с динамикой суправентрикулярной экстрасистолии после индукции суперовуляции, %

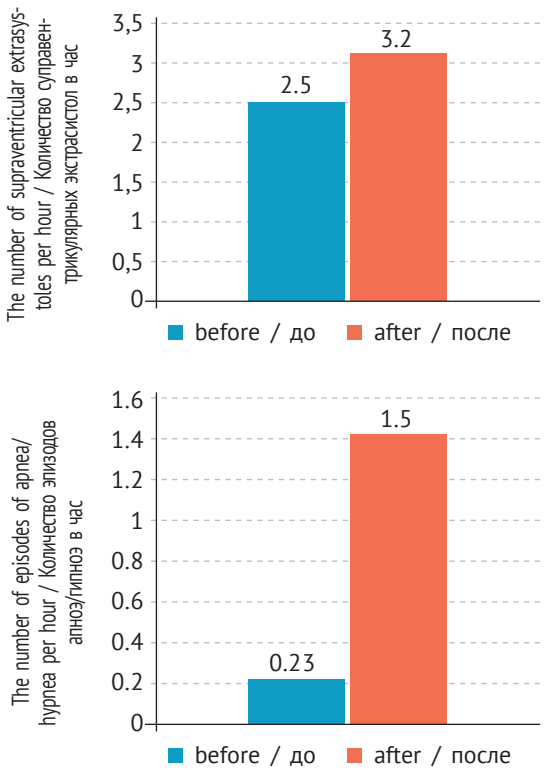

Fig. 2. The number of supraventricular extrasystoles and episodes of apnea/hypnea in women before and after the induction of superovulation ($p < 0.05$)

Рис. 2. Количество суправентрикулярных экстрасистол и эпизодов апноэ/гипноэ у женщин до и после индукции суперовуляции ($p < 0,05$)

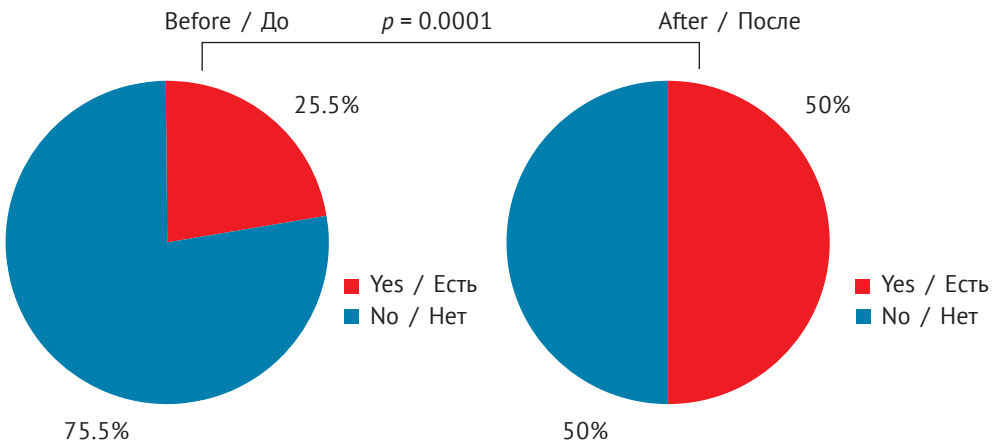

Fig. 3. The proportion of women with episodes of apnea/hypnea before and after the induction of superovulation, % ($p < 0,01$)
Рис. 3. Доля женщин с эпизодами апноэ/гипноэ до и после индукции суперовуляции, % ($p < 0,01$)

cholesterol (4.52 ± 0.47 and 4.08 ± 0.66 mmol/L, respectively, $p < 0.05$), and erythrocyte sedimentation rate (7.42 ± 1.73 and 5.95 ± 2.23 mm/h, respectively, $p < 0.05$) were noted.

Using regression analysis, it was found that the determinants of the risk of supraventricular extrasystole after the induction of superovulation can be deterioration in the daily profile of blood pressure (BP) and HR and disorder of the vagosympathetic balance of the autonomic nervous system (Table 3).

Special aspects of the BP daily profile that affect directly the emergence of rhythm disturbances in women, an increase in BP variability, worsening of the morning BP changes, an increase in the 12-h amplitudes of systolic and diastolic BP, and an increase in the 24-h amplitudes of systolic and diastolic BP should be noted. In particular, in the subgroup of female patients with negative dynamics in the form of an increase in supraventricular extrasystole after induction of superovulation, the morning rise in systolic BP was higher than in the subgroup without negative dynamics after induction of superovulation (49.4 ± 4.7 and 25.6 ± 6.1 mmHg, respectively, $p < 0.01$). This is also true for the morning increase in diastolic BP (47.1 ± 6.2 and 22.8 ± 8.3 mm Hg, respectively, $p < 0.01$). The emergence of supraventricular disturbances of the cardiac rhythm was also influenced by the initial and subsequent levels of the average daily and night HR. Thus, in the subgroup of female patients who had an increase in the number of supraventricular extrasystoles, the average daily HR was higher than that in the subgroup of women without negative dynamics (83.7 ± 5.3 and 77.1 ± 9.7 beats/min, respectively, $p < 0.01$). The emergence of supraventricular extrasystole was associated with a change in the vagosympathetic balance both before (LF/HF: $B = 0.31$, $p < 0.01$) and after induction of superovulation (LF/HF: $B = 0.40$, $p < 0.01$).

The relative risk of supraventricular extrasystole under the influence of superovulation induction was determined. In female patients with supraventricular extrasystole registered before the induction of superovulation, the relative risk of its increase in day 1 after the manipulation was 1.13 compared with women who did not initially have supraventricular extrasystole (95% CI 0.57–2.14). Therefore, the presence of supraventricular extrasystole before the induction of superovulation increases the risk by 1.13 times in day 1 after manipulation. The relative risk of increased episodes of apnea-hypopnea under the influence of induction of superovulation was also calculated. In women with apnea-hypopnea episodes registered before induction of superovulation, the relative risk of increasing their rate on day 1 after manipulation was 2.82 compared with women who did not have apnea-hypopnea before induction of superovulation (95% CI 2.02–3.94) Therefore, the presence of episodes of apnea-hypopnea before induction of superovulation increases the risk by 2.8 times after the manipulation.

CONCLUSION

Superovulation induction is associated with a significant increase in the average daily HR max ($p < 0.01$) and, therefore, with an increase in myocardial oxygen demand. Induction of superovulation promotes the development of supraventricular rhythm disturbances and an increase in episodes of apnea-hypopnea. Predictors of supraventricular rhythm disturbances include unfavorable daily values of HR and BP, as well as disorders of the autonomic regulation of cardiac activity. The emergence of rhythm disturbances is associated with both the initial functional condition of the cardiovascular system and its response to the induction

Table 3 / Таблица 3

The results of a step-by-step regression analysis of the influence of the studied variables on the appearance of supraventricular extrasystole after superovulation induction

Результаты пошагового регрессионного анализа влияния изучаемых переменных на появление суправентрикулярной экстрасистолии после индукции суперовуляции

Independent variables / Независимые переменные	Coefficient regressions *B* / Коэффициент регрессии *B*	*p*
Index apnea/hypnea / Индекс апноэ/гипноэ	0.40	<0.01
Average daily heart rate / Среднедневная ЧСС	1.63	<0.01
Average night heart rate / Средненочная ЧСС	1.97	<0.01
Morning rise of systolic blood pressure / Величина утреннего ↑ САД	4.76	<0.01
Morning rise of diastolic blood pressure / Величина утреннего ↑ ДАД	5.64	<0.01
24-hour amplitude of diastolic blood pressure / 24-часовая амплитуда ДАД	0.53	<0.01
12-hour amplitude of systolic blood pressure / 12-часовая амплитуда САД	0.45	<0.01
12-hour amplitude of diastolic blood pressure / 12-часовая амплитуда ДАД	0.18	<0.01
Variability of systolic blood pressure by day / Вариабельность САД днем	0.79	<0.01
Variability of mean blood pressure by day / Вариабельность среднего АД днем	0.64	<0.01
Variability of systolic arterial pressure at night / Вариабельность САД ночью	2.67	<0.01
Variability of diastolic blood pressure at night / Вариабельность ДАД ночью	0.23	<0.01
Variability of mean blood pressure at night / Вариабельность среднего АД ночью	1.83	<0.01
Index LF/HF day / Показатель LF/HF днем	0.40	<0.01
SDNNidx / SDNNidx	0.22	<0.01
rMSSD / rMSSD	–0.23	<0.01
R^2 models = 0.99, F = 4.82; p = 0.001 / R^2 модели = 0,99, F = 4,82; p = 0,001		

Note. LF/HF ratio – characterizes the balance of sympathetic and parasympathetic effects on the heart; SDNNidx (ms) – the average of all standard deviations over the entire recording array (triangular index), characterizes the general state of heart rate variability; rMSSD is the square root of the mean squares of the differences in the values of successive R–R intervals, reflects the activity of the parasympathetic link of autonomic regulation.

Примечание. Соотношение LF/HF — характеризует баланс симпатических и парасимпатических влияний на сердце; SDNNidx (мс) — среднее из всех стандартных отклонений по всему массиву записи (триангулярный индекс), характеризует общее состояние вариабельности сердечного ритма; rMSSD — квадратный корень из среднего значения квадратов разностей величин последовательных интервалов R–R, отражает активность парасимпатического звена вегетативной регуляции. ЧСС — частота сердечных сокращений, АД — артериальное давление, САД — систолическое артериальное давление, ДАД — диастолическое артериальное давление.

of superovulation. The relative risk of supraventricular extrasystole in practically healthy women under the influence of superovulation induction in IVF was 1.13 (95% CI 0.57–2.14). The relative risk of apnea-hypopnea in practically healthy women under the influence of superovulation induction in IVF was 2.82 (95% CI 2.02–3.94). Induction of superovulation can cause an adverse effect on the functional state of the cardiovascular system of women. In women planning IVF, it is advisable to assess the functional condition of the cardiovascular system using daily monitoring of ECG and BP. This will enable to prepare a woman in advance for the upcoming procedure and avoid adverse reactions in the cardiovascular system.

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