Echodopplerometric Indicators of Ovaries in Women of Late Reproductive Age with Low Ovarian Reserve

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Abstract The study included 90 women of late reproductive age. Based on the level of ovarian reserve, all participants were divided into three groups: Group I consisted of 30 women with low ovarian reserve, Group II comprised 30 women with very low ovarian reserve. The control group was made up of 30 healthy women with a normal level of ovarian reserve. The results of the study showed that women of late reproductive age with low and very low ovarian reserve have significant changes in hormonal profile and echodopplerometric indicators compared to healthy women. These changes include elevated levels of FSH and LH, decreased level of AMH, reduced ovarian volume, decreased number of antral follicles, and impaired ovarian blood supply. The correlation analysis between age and average ovarian volume revealed a weak inverse correlation ($r=-0.25$), and the correlation analysis between age and the total number of antral follicles showed a weak inverse correlation ($r=-0.23$). Thus, echodopplerometric indicators and hormonal analysis can serve as important methods for assessing ovarian reserve in women of late reproductive age.

Keywords Late reproductive age, Ovarian reserve, Ovarian echodopplerometry

1. Introduction

In the modern world, reproductive health issues occupy one of the leading places among medical and social tasks [1-3]. One of the key aspects defining women's reproductive health is ovarian reserve [4-6]. It reflects the functional ability of the ovaries to produce eggs capable of fertilization, which directly affects the possibility of conception and successful pregnancy [7-10]. With age, there is a natural decline in ovarian reserve, which is especially relevant for women of late reproductive age [11-13]. Studying the echodopplerometric indicators of the ovaries allows for the assessment of blood supply and structural changes in the ovaries, which, in turn, provides the opportunity to evaluate their functional state [14-17].

Despite a significant amount of research dedicated to assessing ovarian reserve, there is still a need for the development of more accurate and informative diagnostic methods capable of assessing the real state of a woman's reproductive system [18-23]. At the same time, the decline in ovarian reserve with age is an incontrovertible fact, making it important to timely identify and correct possible reproductive disorders.

The purpose of this study is to assess the echodopplerometric indicators of the ovaries in women of late reproductive age with low ovarian reserve and to identify possible correlations between age and echographic markers of ovarian reserve.

2. Materials and Methods

The study included 90 women of late reproductive age. Based on the level of ovarian reserve, all participants were divided into three groups: Group I - 30 women with low ovarian reserve, Group II - 30 women with very low ovarian reserve. The control group consisted of 30 healthy women with a normal level of ovarian reserve. All patients underwent clinical-laboratory studies, analysis of the hormonal profile, and ultrasound examination (US) with dopplerometry.

The hormonal analysis was conducted to assess the levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), estradiol, progesterone, anti-Müllerian hormone (AMH), and other hormones relevant for evaluating ovarian reserve.

The ultrasound examination of the ovaries with dopplerometry was carried out to assess the anatomical and functional characteristics of the ovaries, including the volume of the ovaries, the number of antral follicles, and blood flow indicators in the ovarian arteries. The study was performed in the first phase of the menstrual cycle (days 3-5) using a high-resolution ultrasound device with Doppler function.

Table 1.   Hormonal Status Indicators in Women of Late Reproductive Age, M±m

Group	FSH (IU/L)	LH (IU/L)	AMH (ng/ml)	Estradiol (pg/ml)	Progesterone (ng/ml)	Testosterone (ng/ml)
Group I, n=30	12.3±0,12	9.1±0,14	1.2±0,12	45±0,14	0.8±0,10	0.4±0,10
Group II, n=30	15.8±0,10	18.2±0,14	0.5±0,12	30±0,10	0.5±0,12	0.35±0,14
Control group, n=30	6.4±0,14	5.5±0,12	4,5±0,11	60±0,12	1.2±0,14	0.5±0,7

Note: *indicates that the parameters of the control group are statistically significant, p>0.05.

3. Study Results

The results of the hormonal status analysis in all women of late reproductive age showed that the level of follicle-stimulating hormone (FSH) in 33.3% of women in Group I was 12.3±0.12 IU/L, and in 33.3% of women in Group II – 15.8±0.10 IU/L. This is significantly higher than the reference values, indicating a decrease in ovarian reserve. In the control group, the average level of FSH was within the normal range – 6.4±0.14 IU/L. There was an increase in luteinizing hormone (LH) in 33.3% of women in Group II to 18.2±0.14 IU/L, while in 33.3% of women in Group I and in the control group, LH levels were 9.1±0.14 IU/L and 5.5±0.12 IU/L, respectively.

The average level of anti-Müllerian hormone (AMH) in 33.3% of women in Group I was 1.2±0.12 ng/mL, and in 33.3% of women in Group II – 0.5±0.12 ng/mL. This is significantly lower than in the control group, where this indicator was 4.5±0.11 ng/mL, highlighting the decrease in ovarian reserve (see Table 1).

In 33.3% of women in Group I, the average level of estradiol was 45±0.14 pg/ml, indicating the lower limit of normal. In 33.3% of women in Group II, the average level decreased to 30±0.10 pg/ml, demonstrating a reduction in estrogen activity. In the control group, the average level of estradiol was 60±0.12 pg/ml, corresponding to an optimal level within the reference values. In 33.3% of women in Group I, the average level of progesterone was 0.8±0.10 ng/ml, which is within normal limits. In 33.3% of women in Group II, the average level was 0.5±0.12 ng/ml, indicating the lower limit of normal and a decrease in progesterone production. In the control group, the average level of progesterone was 1.2±0.14 ng/ml, which is an optimal indicator. In 33.3% of women in Group I, the average level of testosterone was 0.4±0.10 ng/ml, which corresponds to the norm. In 33.3% of women in Group II, the average level slightly decreased to 0.35±0.14 ng/ml, remaining within normal values. In the control group, the average level of testosterone was 0.5±0.7 ng/ml, which is also within the reference values. The analysis of echodopplerometric indicators showed that the volume of ovaries in Groups I and II observed a significant decrease in ovarian volume to 7.5±0.12 cm³ and 1.3±0.14 cm³, respectively, compared to the control group (8.0±0.02 cm³). The number of antral follicles in Group I was an average of 5±0.14, in Group II - 4±0.11, while in the control group, their number was significantly higher - 10±0.14. The average diameter of follicles

(mm) in the groups was 5.0±0.14, 4.0±0.12, and 8.0±0.14 mm, respectively.

Table 2.   Ultrasound indicators of ovaries in women of late reproductive age, M±m

Indicator	Group I, n=30	Group II, n=30	Control group, n=30
Average ovarian volume (cm³)	7.5±0.12	7.0±0.14	8.0±0.02
Total number of antral follicles (n)	5±0.12	4±0.11	10±0.14
Average follicle diameter (mm)	5.0±0.14	4.0±0.12	8.0±0.12

Note: *indicates that the parameters of the control group are statistically significant, p>0.05

The study of structural changes in the ovaries showed that in Group I, thickening of the ovarian capsule was observed, which impedes ovulation. In Group II, structural changes were more pronounced: increased echogenicity of the stroma indicating fibrous changes, and significant thickening of the ovarian capsule. In 33.3% of women in the control group, pathological structural changes were not identified, the echostructure of the ovaries was homogeneous, and the capsule was not thickened.

The analysis of blood flow indicators in the ovarian arteries in Groups I and II revealed a high resistance index (RI) – 0.8 and 0.85 respectively in the groups, and the pulsatility index (PI) was 1.5 and 1.6 respectively in the groups, indicating impaired ovarian blood supply. In the control group, these indicators were RI – 0.7 and PI – 1.2 (see Fig. 1).

Additionally, we conducted a study to investigate the correlation between age and the average volume of the ovaries, between age and the number of antral follicles, between age and the thickness of the endometrium, as well as between age and the restoration of fertility. The correlation analysis between age and the average ovarian volume revealed a weak inverse correlation between the participants' age and the average volume of their ovaries (correlation coefficient (r=−0.25). This indicates that with increasing age, the average ovarian volume tends to decrease slightly (see Fig. 2).

The correlation analysis between age and the total number of antral follicles revealed a weak inverse correlation between age and the number of antral follicles (correlation coefficient r=−0.23). This indicates a decrease in the number of antral follicles in women with age, which may be associated with a gradual reduction in ovarian reserve (see Fig. 3).
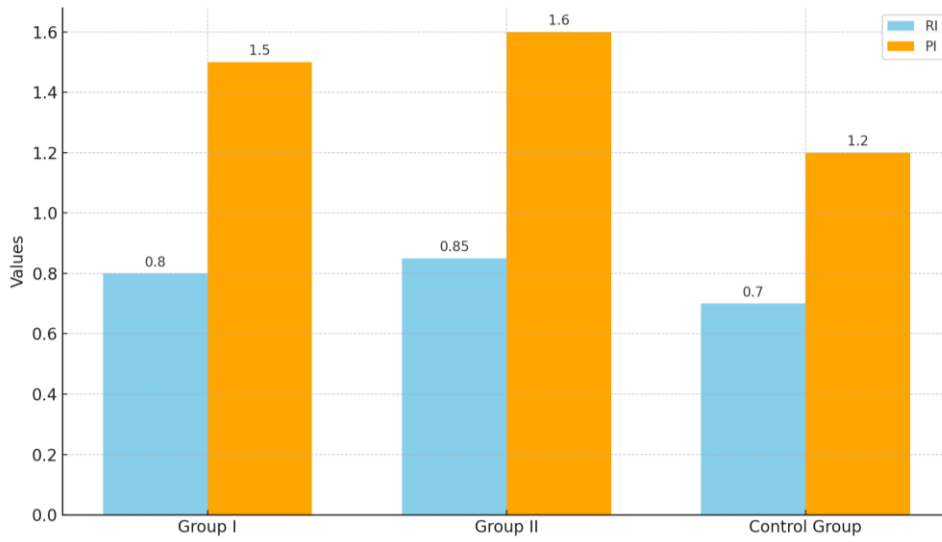
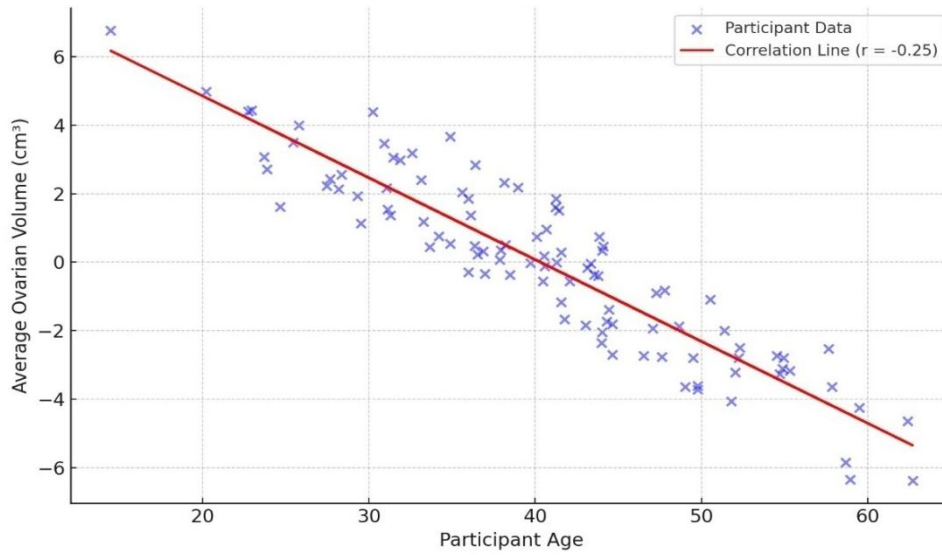**Figure 1.** Blood flow parameters in the ovarian arteries of the examined women

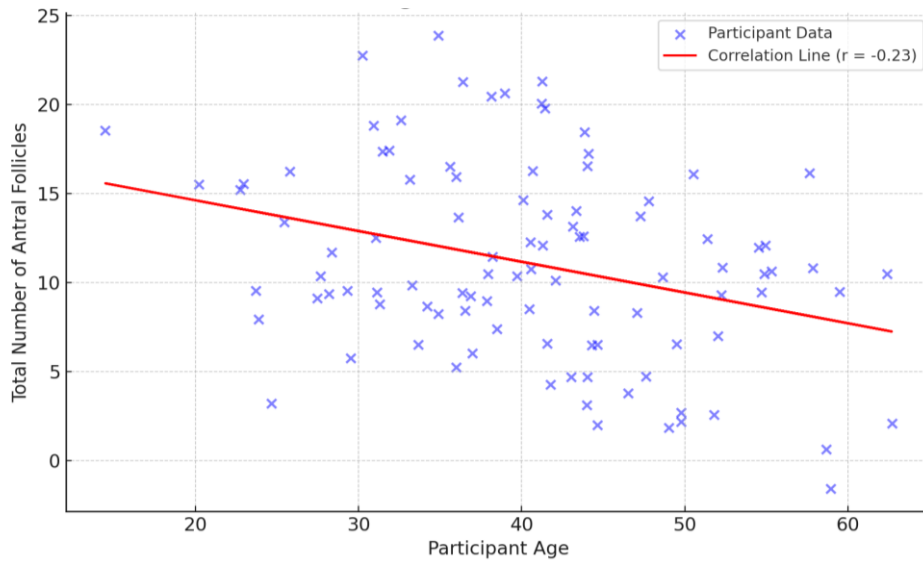**Figure 2.** Correlation between age and average ovarian volume

Figure 3. Correlation between age and the total number of antral follicles

Thus, women of late reproductive age with low and very low ovarian reserve exhibit significant changes in the hormonal profile and echodopplerometric indicators compared to healthy women. These changes include increased levels of FSH and LH, decreased levels of AMH, reduced ovarian volume, a decrease in the number of antral follicles, and impaired blood supply to the ovaries. The correlation analysis between the participants' age and the average volume of their ovaries showed a weak inverse correlation (correlation coefficient r=−0.25), and the correlation analysis between age and the total number of antral follicles also revealed a weak inverse correlation (correlation coefficient r=−0.23).

4. Conclusions

The results of our study indicate that women of late reproductive age with low and very low ovarian reserve have significant changes in hormonal profile and echodopplerometric indicators compared to healthy women. These changes include elevated levels of FSH and LH, a decrease in AMH levels, reduced ovarian volume, fewer antral follicles, and deteriorated ovarian blood supply. The correlation analysis between age and average ovarian volume revealed a weak inverse correlation (correlation coefficient r=−0.25), and the analysis between age and the total number of antral follicles showed a weak inverse correlation (correlation coefficient r=−0.23). Therefore, echodopplerometric indicators and hormonal analysis can serve as important methods for assessing ovarian reserve in women of late reproductive age.

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