ECRONICON OPEN ACCESS

EC GYNAECOLOGY
Research Article

Transvaginal Ultrasonographic Diagnosis of Luteal Phase Deficiency

Abdullaiev R Ya[1]*, Kulikova FI[2], Lysenko TP[1], Golovko TS[3], Baibakov VM[2], Kosse VA[2], Derkach AK[2] and Semenenko VM[2]

[1]*Kharkov Medical Academy of Postgraduate Education, Ukraine*

[2]*Dnipro Medical Institution of Traditional and Alternative medicine, Ukraine*

[3]*National Cancer Institute, Ukraine*

***Corresponding Author**: Abdullaiev R Ya, Kharkiv Medical Academy of Postgraduate Education, Kharkiv, Ukraine.

Received: April 21, 2019; **Published:** May 13, 2019

Abstract

Introduction: Luteal phase deficiency (LPhD) of the menstrual cycle is a violation of ovarian function, characterized by hypofunction of the corpus luteum of the ovary. Insufficient synthesis of progesterone leads to insufficient secretory transformation of the endometrium, changes in the function of the fallopian tubes, impaired endometrial implantation, which is clinically manifested by infertility or spontaneous miscarriage in the first trimester of pregnancy.

Objective: Determine the most significant ultrasound criteria for luteal phase deficiency.

Materials and Methods: A retrospective analysis of the results of transvaginal echography of the uterus and ovaries of 54 women aged 21 - 35 years was carried out, who underwent ovulation during ultrasonographic monitoring, but did not become pregnant and were diagnosed with a lutein phase deficiency (LPhD). The control group consisted of 32 fertile women with a regular menstrual cycle, ovulation and subsequent pregnancy.

Results: Among women with LPhD, ovulation was significantly more frequent on the 15th day of the cycle (17 - 31.5 ± 6.4%), among fertile women on the 13th day of the cycle (14 - 43.8 ± 8.8%).

The average M-echo value in the group of LPhD on the 17th day of the menstrual cycle was 7.8 ± 1.2 mm, in CG - 12.5 ± 1.1 mm ($p < 0.01$); on the 22th day - 7.9 ± 1.1 mm and 13.6 ± 1.3 mm ($p < 0.001$), respectively. The RI in a spiral arteries on the 17th and 22th days of the menstrual cycle in the group with LPhD was significantly higher ($P < 0.05$) than in the CG (0.56 ± 0.04 vs 0.47 ± 0.02 and 0.59 ± 0.03 vs 0.49 ± 0.02). Heterogeneous corpus luteum (CL) on 22th day of the menstrual cycle was significantly rare ($P < 0.001$) recorded in women with LPhD, than in fertile women (7.4 ± 3.6% vs 65.6 ± 8.8). Enhanced CL vascularization on next day of ovulation in the LPhD group was observed in 9.3 ± 4.0% cases, on 17th day - in 5.6 ± 3.1% cases (among fertile group in 37.5 ± 8.6% cases; $P < 0,05$), on the 22th day - only among fertile women.

Conclusions:

1. In women with LPhD, ovulation is more often delayed and this leads to a reduction in the duration of the corpus luteum (CL).
2. In LPhD, heterogeneous CL is markedly less frequently ($p < 0.001$) than in fertile (7.4 ± 3.6 and 65.6 ± 8.4%). The intensity of blood flow in CL in a patients with LPhD is significantly less than in fertile women (9.3 ± 4.0 and 37.5 ± 8.6%, $p < 0.01$). Vascularization of the CL is reduced, in the mode of color Doppler along its periphery there is no vascular corolla.
3. Doppler parameters of LPhD are: low Vs in CL at the 17th (20.3 ± 2.1 cm/c) and 22th (18.5 ± 2.3 cm/s) days of the cycle, a high RI (0.61 ± 0.04 per the wall of preovulatory follicle (POF); 0.47 ± 0.03 on the next day of ovulation; 0.53 ± 0.04 on the 17th day of the cycle; 0.55 ± 0.04 on the 22th day of the cycle, respectively) and PI (1.05 ± 0.05 on the POF wall; 0.84 ± 0.05 on the next day of ovulation; 0.92 ± 0.05 17th day of the cycle; 0.94 ± 0.05 on the 22th day of the cycle, respectively.
4. With LPhD in the middle secretory phase, the M-echo thickness does not exceed 9 mm, the endometrial vascularization is weak, the blood flow in the spiral arteries is low-speed (6.9 ± 0.8 cm/s) and high-resistant (0.59 ± 0.03).

Keywords: *Transvaginal Ultrasound; Luteal Phase Deficiency*

Introduction

Luteal Phase Deficiency (LPhD), results from low endogenous progesterone production and the resultant insufficiency to maintain a secretory endometrium to allow embryo implantation and growth [1]. It is known that the normal menstrual cycle consists of the follicular and luteal phases. By the end of the follicular phase, estrodiol is produced from the granulose cell of the dominant follicle, which in turn stimulates the release of luteinizing hormone, which is released from the anterior lobe of the pituitary gland [2]. After ovulation, the follicle turns into a corpus luteum, which produces progesterone from the granulosa-lutein. In the luteal phase, an increase in progesterone level stimulates the endometrium, thereby preparing it for implantation of the blastocyst [3].

Previously, endometrial biopsy was used to diagnose luteal insufficiency. Studies conducted with Coutifaris C., *et al.* (2004) demonstrated low diagnostic value and inexpediency of using the method due to invasiveness [4]. Usadi RS., *et al.* (2008) compared the results of endometrial biopsy and progesterone levels in women with luteal phase deficiency. At the same time, a very low correlation was found and it was concluded that endometrial histological studies are not a reliable method for diagnosing luteal phase deficiency [5].

The presence of a link between the luteal phase deficiency and infertility remains controversial. Crawford NM., *et al.* (2017) studied 1,635 menstrual cycles, of which 18% were with a short luteal phase lasting less than 11 days. When comparing the results of the study of this group with patients whose duration of the luteal phase was 14 days, did not reveal a statistically significant increase in the number of infertility among the first [6].

Recent studies also demonstrate the lack of clear diagnostic criteria for the luteal phase deficiency [7]. Research Miravet-Valenciano JA (2015) demonstrate the promise of studying the endometrial susceptibility to implantation using a large number of genes in combination with a computational predictor [8]. A comparative prospective study of eighty-six healthy oocyte donors, demonstrated the endometrial receptivity array as a superior diagnostic method for detecting endometrial receptivity compared to histologic evaluation [9]. At the same time, a more detailed study of this technology is recommended prior to considering it the vanguard technology for clinical utilization [10].

Previous studies have shown changes in the Doppler spectrum of blood flow in the uterine and ovarian arteries during luteal phase deficiency [11]. It is of interest to study changes in the endometrium and ovaries in different phases of the menstrual cycle in women with luteal phase deficiency with the help of transvaginal echography.

Objective of the Study

Determine the most significant ultrasound criteria for luteal phase deficiency.

Materials and Methods

A retrospective analysis of the results of transvaginal echography of the uterus and ovaries of 54 women aged 21 - 35 years was carried out, who underwent ovulation during ultrasonographic monitoring, but did not become pregnant and were diagnosed with a lutein phase deficiency (LPhD). Of these, 19 (35.2 ± 6.5%) women aged 21 - 25 years old, 26 (48.1 ± 6.8%) aged 26 - 30 years and 9 (16.7 ± 5.1%) aged 31-35 years. Shortening of the menstrual cycle was observed in 13 (24.1 ± 5.9%), obesity - in 11 (20.4 ± 5.5%), oligomenorrhea - in 4 (7.4 ± 3.6%), endometriosis - in 5 (9.3 ± 4.0%) cases. The control group consisted of 32 fertile women with a regular menstrual cycle, ovulation and subsequent pregnancy. All women underwent transvaginal ultrasonography in two-dimensional and Doppler modes.

In order to determine the day of ovulation in the studied groups, ultrasound monitoring of the development of the dominant follicle (DF) was conducted from the 11^{th} to the 15^{th} days of the cycle. The diameter of DF, the presence of an oviparous tubercle in its wall, the systolic velocity, the index of resistance and pulsation of blood flow in the wall of DF were determined.

Results

Table 1 shows the days of ovulation among fertile women and women with LPhD. In the control group (CG) on the 11^{th} day of the menstrual cycle, ovulation occurred in 2 (6.3 ± 4.3%) women, on the 12^{th} day - in 4 (12.5 ± 5.9%), by 13^{th} day - in 14 (43.8 ± 8.8%), on the 14^{th} day of the cycle - in 9 (28.1 ± 8.1%) and on the 15^{th} day - in 3 (9.4 ± 5,2%) women, respectively. It is seen that fertile women on the 13^{th} day of the cycle ovulation occurred significantly ($P < 0.05$) more often than other days. Among women with LPhD, on the 11^{th} day of the menstrual cycle, ovulation occurred in 3 (5.6 ± 3.1%) cases, on the 12^{th} day - in 8 (14.8 ± 4.9%), on the 13^{th} - in 10 (18.5 ± 5.3%), on

the 14th - in 16 (29.6 ± 6.2%) and on the 15th day - in 17 (31.5 ± 6.4%) cases, respectively (Table 1). Relatively late ovulation with a short menstrual cycle in women with LPhD leads to a shortening of the duration of the corpus luteum.

Group of patients	Days of menstrual cycle				
	11 th	12 th	13 th	14 th	15 th
LFD (n = 54)	3 (5,6 ± 3,1%)	8 (14,8 ± 4,9%)	10 (18,5 ± 5,3%)	16 (29,6 ± 6,2%)	17 (31,5 ± 6,4%) P < 0,05
CG (n = 32)	2 (6,3 ± 4,3%)	4 (12,5 ± 5,9%)	14 (43,7 ± 8,8%) P < 0,05	9 (28,1 ± 8,1%)	3 (9,4 ± 5,2%)

***Table 1**: Ovulatory days in women of the control group and luteal phase deficiency.*

To determine the peculiarities of menstrual cyclic transformations in the endometrium, we compared the parameters of the endometrium (thickness M-echo, index Te/Tu, endometrial echogenicity) in a patients with LPhD and CG on the next day of ovulation, on the 17th and 22th days of menstrual cycle (Table 2).

Parameters		Patients group and menstrual days					
	The next day of ovulation		17th day		22th day		
	LPhD (n = 54)	CG (n = 32)	LPhD (n = 54)	CG (n = 32)	LPhD (n = 54)	CG (n = 32)	
M echo, mm	6,1 - 9,0	37 68,5 ± 6,4%	2 6,3 ± 4,3%	35 64,8 ± 6,6%	-	36 66,7 ± 6,5%	-
	9,1 - 12,0	13 24,1 ± 5,9%	21 65,6 ± 8,5%	14 25,9 ± 6,0%	18 56,2 ± 8,8%	15 27,8 ± 6,2%	24 75,0 ± 7,7%
	> 12	4 7,4 ± 3,6%	9 28,1 ± 8,1%	5 9,3 ± 4,0%	14 43,8 ± 8,8%	3 5,5 ± 3,1%	8 25,0 ± 7,7%
M ± m, мм		7,6 ± 1,2	11,2 ± 1,1 P < 0,05	7,8 ± 1,2	12,5 ± 1,1 P < 0,01	7,9 ± 1,1	13,6 ± 1,3 P < 0,001
Hyperechoic endometrium		-	-	9 16,6 ± 5,1%	18 56,3 ± 8,8% P < 0,001	11 20,4 ± 4,5%	23 71,9 ± 7,9% P < 0,001
Isoechoic endometrium		19 35,2 ± 6,6%	9 28,1 ± 7,9%	34 63,0 ± 6,6%	14 43,7 ± 8,8%	35 64,8 ± 7,9% P < 0,01	9 28,1 ± 7,9%
Hypoechoic endometrium		35 64,8 ± 6,6%	23 71,9 ± 7,9%	11 20,4 ± 5,5%	-	8 14,8 ± 4,9%	-

***Table 2:** Dynamics of echographic parameters of the endometrium in women with LPhD and of CG.*

From table 2 it can be seen that the thickness of the M-echo within 9 - 12 mm or more 12 mm the entire observation period in the CG was significantly more frequent than among women with LPhD. The average M-echo value the next day of ovulation in a patients with LPhD was 7.6 ± 1.2 mm and in the CG - 11.2 ± 1.1 mm (P < 0.05); on the 17th day of the menstrual cycle - 7.8 ± 1.2 mm and 12.5 ± 1.1 mm (P < 0.01); on the 22th day - 7.9 ± 1.1 mm and 13.6 ± 1.3 mm (P < 0.001) respectively.

Hyperechoic endometrium on the 17th day of the cycle among women with LPhD was recorded at 9 (16.6 ± 5.1%) of cases, and in the CG in 18 (56.3 ± 8.8%) cases (P < 0.001), on the 22th day - at 11 (20.4 ± 4.5%) and in 23 (71.9 ± 7.9%) cases (P < 0.001), respectively.

Isoechoic endometrium, on the contrary, in women with LPhD on the 22th day of the cycle was observed significantly (P < 0.01) more often than in CG (64.8 ± 7.9% vs 28.1 ± 7.9%).

The dopplerographic parameters of blood flow was recorded in the uterine (UA), arcuate (AA), radial (RA), basilar (BA) and spiral (SA) arteries (Table 3). A significant difference in Vs of RA between CG and LPhD was observed on the 17th and 22th days of the menstrual cycle (23.6 ± 1.4 vs 19.5 ± 1.1 cm/s; P < 0.01 and 24.1 ± 1.3 vs 18.3 ± 1.1 cm/s; P < 0.001, respectively). The RI index of blood flow in RA in a patients with LPhD and CG significantly (p < 0.01) differed on the 17th day of the cycle (0.71 ± 0.02 vs 0.65 ± 0.02). Vs in BA between CG and LPhD significantly (P < 0.01) differed on the 17th and 22th days of the menstrual cycle (15.9 ± 1.3 vs 12.1 ± 1.2 cm/s and 15.6 ± 1.2 vs 10.9 ± 1.1 cm/s). In the same period, there was a significant difference (P < 0.05) in RI - 0.65 ± 0.03 vs 0.54 ± 0.03 and 0.63 ± 0.03 vs 0.52 ± 0.02.

Dopplerometric parameters		**Patients group and menstrual days**					
	The next day of ovulation		**17th day**		**22th day**		
	LPhD (n = 54)	CG (n = 32)	LPhD (n = 54)	CG (n = 32)	LPhD (n = 54)	CG (n = 32)	
UA	Vs, cm/c	46,8 ± 2,5	47,2 ± 2,1	45,1 ± 2,5	51,7 ± 2,6	44,2 ± 2,1	48,1 ± 2,3
	RI	0,89 ± 0,02	0,85 ± 0,03	0,87 ± 0,02	0,83 ± 0,02	0,86 ± 0,02	0,84 ± 0,03
AA	Vs, cm/c	36,3 ± 1,4	38,9 ± 1,7	37,8 ± 1,9	43,2 ± 2,1	37,1 ± 1,8	42,9 ± 2,3
	RI	0,79 ± 0,03	0,76 ± 0,03	0,79 ± 0,03	0,73 ± 0,02	0,78 ± 0,03	0,74 ± 0,03
RA	Vs, cm/c	17,6 ± 1,1	19,7 ± 1,3	19,5 ± 1,1	23,6 ± 1,4*	18,3 ± 1,1	24,1 ± 1,3*
	RI	0,74 ± 0,03	0,67 ± 0,02	0,71 ± 0,02 P < 0,05	0,65 ± 0,02	0,69 ± 0,02	0,66 ± 0,03
BA	Vs, cm/c	13,1 ± 1,2	13,6 ± 1,3	12,1 ± 1,2	15,9 ± 1,3*	10,9 ± 1,1	15,6 ± 1,2*
	RI	0,67 ± 0,02	0,57 ± 0,03	0,65 ± 0,03 P < 0,05	0,54 ± 0,03	0,63 ± 0,03 P < 0,05	0,52 ± 0,02
SA	Vs, cm/c	-	-	7,5 ± 0,6	9,2 ± 0,7	6,9 ± 0,8	9,4 ± 0,6 P < 0,05
	RI	-	-	0,56 ± 0,04 P < 0,05	0,47 ± 0,02	0,59 ± 0,03 P < 0,05	0,49 ± 0,02

Table 3: *Dynamics of Vs and RI in the uterine vessels in women with LPhD and CG.*

In the secretory phase, the blood flow in the spiral arteries (SA) was recorded in both groups and only on 22th day, the Vs value in women of CG was significantly (P < 0.05) higher than in a patients with LPhD (9.4 ± 0.6 vs 6.9 ± 0.8 cm/s). The RI on the 17th and 22th days of the menstrual cycle in the group with LPhD was significantly higher (P < 0.05) than in the CG (0.56 ± 0.04 vs 0.47 ± 0.02 and 0.59 ± 0.03 vs 0.49 ± 0.02).

Given that the luteal phase deficiency is manifested not only by a change in the structure of the endometrium, but also of the corpus luteum, we compared the echographic parameters of the corpus luteum of women with LPhD and CG. The diameter of corpus luteum, its structure (cystic, hypoechoic, heterogeneous) was determined (Table 4).

Ultrasonographic parameters	**The patients group**	**The days of menstrual cycle**		
		The next day of ovulation	**17th day**	**22th day**
Diameter of corpus luteum (CL), mm	CG (n = 32)	18,3 ± 1,2	17,1 ± 0,9*	16,9 ± 0,7*
	LPhD (n = 54)	16,1 ± 0,8	14,8 ± 0,6	13,7 ± 0,5
Volume of CL, cm^3	CG (n = 32)	3,2 ± 0,7	2,9 ± 0,6	2,6 ± 0,5*
	LPhD (n = 54)	2,2 ± 0,6	1,7 ± 0,5	1,3 ± 0,4
Vcl/Vo	CG (n = 32)	0,35 ± 0,06	0,34 ± 0,06	0,34 ± 0,05*
	LPhD (n = 54)	0,28 ± 0,05	0,21 ± 0,05	0,17 ± 0,04
Cystic corpus luteum	CG (n = 32)	4 (12,5 ± 5,8%)	-	-
	LPhD (n = 54)	15 (27,8 ± 6,1%)	14 (25,9 ± 6,0%)	13 (24,1 ± 5,8%)
Hypoechoic corpus luteum	CG (n = 32)	12 (37,5 ± 8,6%)	11 (34,4 ± 8,4%)	11 (34,4 ± 8,4%)
	LPhD (n = 54)	35 (64,8 ± 6,5%) P < 0,05	36 (66,6 ± 6,4%) P < 0,05	38 (70,4 ± 6,2%) P < 0,05
Heterogeneous corpus luteum	CG (n = 32)	16 (50,0 ± 8,8% P < 0,001	21 (65,6 ± 8,4%) P < 0,001	21 (65,6 ± 8,4%) P < 0,001
	LPhD (n = 54)	4 (7,4 ± 3,6%)	4 (7,4 ± 3,6%)	4 (7,4 ± 3,6%)

Table 4: *Ultrasonographic parameters of corpus luteum in a patients with LPhD and CG.*

As can be seen from table 4, the diameter and the volume of CL, the Vcorpus luteum/Vovary (Vcl/Vo) index for women with LPhD and CG did not differ significantly on the next day of ovulation. The diameter of CL in CG on the 17th and 22th days of the menstrual cycle significantly (P < 0.05) exceeded the rate of group with LPhD (17.1 ± 0.9 vs. 14.8 ± 0.6 mm and 16.9 ± 0.7 vs 13.7 ± 0.5 mm). The volume of CL, index of Vcl/Vo in both groups on the 17th day of the cycle also did not differ significantly. However, on the 22th day of the cycle, the magnitude of these parameters in women of CG was significantly higher than in the group with LPhD - 2.6 ± 0.5 vs 1.3 ± 0.4 cm^3 (P < 0.05), 0.34 ± 0.05 vs 0.17 ± 0.04 (P < 0.01) and 0.67 ± 0.07 vs 0.48 ± 0.05 (P < 0.05), respectively.

Cystic CL in CG was observed only in 4 (12.5 ± 5.8%) cases, and in group of LPhD - in 15 (27.8 ± 6.1%) cases. In the secretory phase, cystic CL in women of CG was not observed, while with LPhD it was 25.9 ± 6.0% and 24.1 ± 5.8%, respectively. Heterogeneous CL, the entire observation period was significantly more often (P < 0.001) recorded in women of CG (50.0 ± 8.8 vs. 7.4 ± 3.6% the next day of ovulation, 65.6 ± 8.4 vs 7.4 ± 3.6% on 17th and 22th days of the menstrual cycle).

There was studied intensity of blood flow in the wall of Corpus Luteum (Table 5). In the color Doppler mode, blood flow was assessed as weak (less than 5 small vascular signals), moderate (in the form of a discontinuous linear corolla on the periphery of CL) and amplified (color corolla on the periphery of CL). During the entire follow-up period, weak CL vascularization among women with LPhD was found to be significantly (P < 0.01) more often than CG. The frequency of registration of moderate vascularization of CL between groups was not significantly different. Enhanced CL vascularization on the 22th day of the cycle was observed only in the CG, and on previous days it was significantly (P < 0.01) more often than in the LPhD group (37.5 ± 8.6 vs 9.3 ± 4.0% and 5.6 ± 3.1%).

Ultrasonographic parameters		**The patients group**	**The days of menstrual cycle**		
		The next day of ovulation	**17th day**	**22th day**	
Vascularization of corpus luteum	Mild	CG (n = 32)	3 (9,4 ± 3,6%)	3 (9,4 ± 3,6%)	4 (12,5 ± 5,8%)
		LPhD (n = 54)	16 (29,6 ± 6,2%) P < 0,05	17 (31,5 ± 6,3%) P < 0,05	22 (40,7 ± 6,7%) P < 0,05
	Moderate	CG (n = 32)	17 (53,1 ± 8,9%)	17 (53,1 ± 8,9%)	15 (46,9 ± 8,9%)
		LPhD (n = 54)	33 (61,1 ± 6,6%)	34 (63,6 ± 6,5%)	32 (59,3 ± 6,7%)
	Severe	CG (n = 32)	12 (37,5 ± 8,6%) P < 0,05	12 (37,5 ± 8,6%) P < 0,05	13 (40,6 ± 8,8%)
		LPhD (n = 54)	5 (9,3 ± 4,0%)	3 (5,6 ± 3,1%)	-

Table 5: *Dopplerographic parameters of blood flow in the wall of corpus luteum in a patients with LFD and CG.*

Hemodynamic parameters of blood flow - the maximum systolic velocity (Vs), resistance (RI) and pulsation (PI) indexes on the wall of the preovulatory follicle (POF), in the wall CL on the next day of ovulation, on the 17th and 22th days of the cycle are presented in the table 6. A significant (P < 0.01) difference in Vs between groups was observed in the secretory phase of the cycle - 28.9 ± 1.9 vs 20.3 ± 2.1 cm/s (on the 17th day) and 27.4 ± 2.1 vs 18,5 ± 2,1 cm/s (on the 22th day).

Dopplerometric parameters	**POF**		**The patients group and menstrual days**					
		The next day of ovulation		**17th**		**22th**		
	LPhD	CG	LPhD	CG	LPhD	CG	LPhD	CG
Vs, см/с	17,8 ± 2,3	21,7 ± 2,2	21,8 ± 2,3	26,9 ± 2,1	20,3 ± 2,1	28,9 ± 1,9 P < 0,05	18,5 ± 2,1	27,4 ± 2,1 P < 0,05
RI	0,61 ± 0,04	0,49 ± 0,02 P < 0,05	0,47 ± 0,03	0,36 ± 0,03 P < 0,05	0,53 ± 0,04	0,41 ± 0,02 P < 0,05	0,55 ± 0,04	0,43 ± 0,02 P < 0,05
PI	1,05 ± 0,05	0,87 ± 0,04 P < 0,05	0,84 ± 0,05	0,65 ± 0,04 P < 0,05	0,92 ± 0,05	0,69 ± 0,04 P < 0,05	0,94 ± 0,05	0,72 ± 0,03 P < 0,05

Table 6: *Dinamics of Vs, RI and PI of POF and CL in a patients with LFD and CG.*

RI and PI the entire observation period in women with LPhD were significantly higher than in the CG. RI on the POF wall in women with LFD was 0.61 ± 0.04, in CG - 0.49 ± 0.02 (P < 0.01); PI - 1.05 ± 0.05 and 0.87 ± 0.04 (P < 0.01), respectively. On the next day of ovulation, the average RI was 0.47 ± 0.03 and 0.36 ± 0.03 (P < 0.05), the PI was 0.84 ± 0.05 and 0.65 ± 0.04 (P < 0.01), respectively. On the 17th day of the cycle, these parameters were 0.53 ± 0.04 and 0.41 ± 0.02 (P < 0.01) and 0.92 ± 0.05 and 0.69 ± 0.04 (P < 0.001), on the 22th day, RI was 0.55 ± 0.04 and 0.43 ± 0.02 (P < 0.01) and PI - 0.94 ± 0.05 and 0.72 ± 0.04 (P < 0.001), respectively.

In order to determine the informative value of hormonal and ultrasound studies, their results on the 22th day of the menstrual cycle were compared. As markers of endometrial readiness for implantation of a fertilized egg, progesterone rates, M-echo thickness, peak systolic velocity (Vs) and resistance index (RI) of blood flow in spiral arteries were evaluated (Table 7).

Patients group	Progesterone nmol/l	The ultrasonographic parameters		
		M-echo, mm	Vs, cm/c	RI
CG	37,1 ± 8,6 (P > 0,05)	13,6 ± 1,3 P < 0,05	9,4 ± 0,6 P < 0,05	0,49 ± 0,02 P < 0,05
LPhD	19,8 ± 5,1	7,9 ± 1,1	6,9 ± 0,8	0,59 ± 0,03

Table 7: *Parameters of Progesteron, M-eco, Vs and RI of spiral arteries at 22th day of menstrual cycle in patients with LPhD and CG.*

As can be seen from table 7, the upper and lower limits of the standard values of progesterone differed 10 times. The average value of progesterone in LPhD was 19.8 ± 5.1 nmol/l, in fertile women - 37.1 ± 8.6 nmol/l (P > 0.05), respectively. At the same time, transvaginal ultrasound revealed a significant (P < 0.01) difference between the thickness of the M-echo in fertile women and women with LPhD (13.6 ± 1.3 and 7.9 ± 1.1 mm, respectively). Vs in the spiral arteries in fertile women was 9.4 ± 0.6 cm/s, and with LPhD - 6.9 ± 0.8 cm/s (P < 0.05), RI - 0.49 ± 0.02 and 0.59 ± 0.03 (P < 0.05), respectively.

The echograms (Figure 1-4) show the changes on the walls of the corpus luteum and in the endometrium after ovulation in the color Doppler mode.

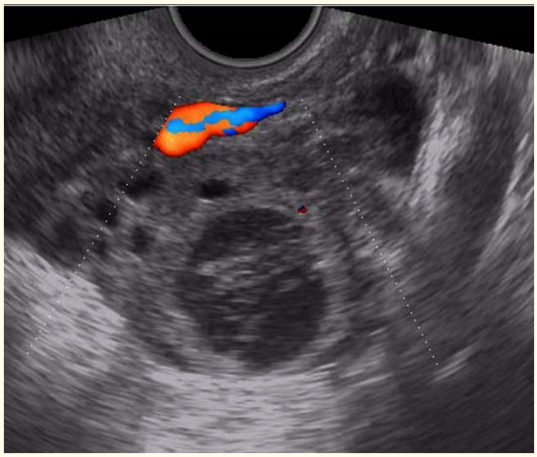

Figure 1: *Transvaginal color Doppler ovarian view of a 32-year-old female with LPhD. On the 17th day of the cycle, a cystic formation with a diameter of less than 2 cm with small linear inclusions and 5 antral follicles is visualized in the ovary. In the color Doppler mode, there are no vascular signals on the wall of the cystic formation.*

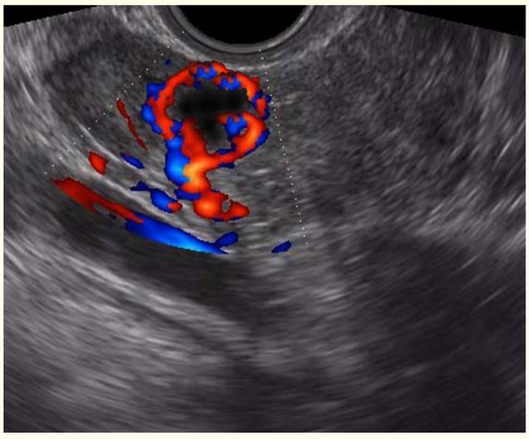

Figure 2: *Transvaginal color Doppler ovarian view of a 28-year-old fertile female next day of ovulation. On the periphery of the corpus luteum a colored corolla is visualized.*

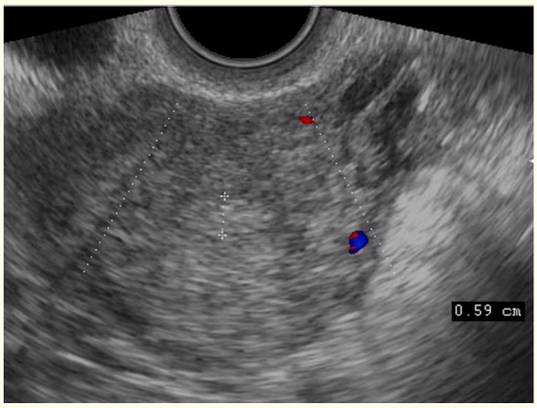

Figure 3: *Transvaginal color Doppler endometrium view of a 29-year-old female with LPhD. On the 22th day of the cycle. M-echo is about 6 mm. In the color Doppler mode, there are no vascular signals on the endometrium.*

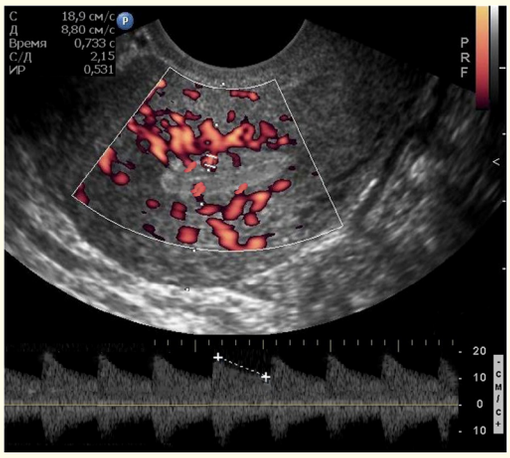

Figure 4: *Transvaginal power Doppler endometrium view of a 34-year-old fertile female on the 22th day of the menstrual cycle. Registration of blood flow in the spiral arteries. Vs is 18,9 cm/c, RI - 0,53.*

Discussion

Approximately 15% of women of child-bearing age have primary or secondary infertility. Luteal phase deficiency is noted in cases of primary infertility and in approximately 35% of couples who have experienced recurrent miscarriage [12]. Menstrual cycle disorders include a spectrum of conditions, from luteal phase deficiency, to oligoovulation, to chronic anovulation [13]. Some researchers suggest that insufficiency of the luteal phase is caused by dysfunction of the corpus luteum, which leads to a decrease in the preparation of the endometrium in the secretory phase of the cycle. Alternatively, luteal phase deficiency may reflect a deficiency in the uterine endometrial response to normal hormonal changes during the luteal phase [14]. Previous studies have shown changes in the Doppler spectrum of blood flow in the uterine and ovarian arteries during luteal phase deficiency [15].

Conclusions

In our studies, cyclical changes in the endometrium and corpus luteum in the luteal phase of menstruation in the B-mode, color and spectral Doppler modes are shown. In addition, the comparison of Doppler studies with hormonal. All this is of great practical importance and will help to better diagnose the luteal phase deficiency.

1. In women with LFD, ovulation is more often delayed and this leads to a reduction in the duration of the corpus luteum (CL).
2. In LFD, heterogeneous CL is markedly less frequently ($p < 0.001$) than in fertile (7.4 ± 3.6 and 65.6 ± 8.4%). The intensity of blood flow in CL in a patients with LFD is significantly less than in fertile women (9.3 ± 4.0 and 37.5 ± 8.6%, $p < 0.01$). Vascularization of the CL is reduced, in the mode of color Doppler along its periphery there is no vascular corolla.
3. Doppler parameters of LFD are: low Vs in CL at the 17th (20.3 ± 2.1 cm/c) and 22th (18.5 ± 2.3 cm/s) days of the cycle, a high RI (0.61 ± 0.04 per the wall of preovulatory follicle; 0.47 ± 0.03 on the next day of ovulation; 0.53 ± 0.04 on the 17th day of the cycle; 0.55 ± 0.04 on the 22th day of the cycle, respectively) and PI (1.05 ± 0.05 on the POF wall; 0.84 ± 0.05 on the next day of ovulation; 0.92 ± 0.05 17th day of the cycle; 0.94 ± 0.05 on the 22th day of the cycle, respectively.
4. With LFD in the middle of secretory cycle, the M-echo thickness does not exceed 9 mm, the endometrial vascularization is weak, the blood flow in the spiral arteries is low-speed (6.9 ± 0.8 cm / s) and high-resistant (0.59 ± 0.03).

Conflict of Interest

The authors declare that they have no conflicts of interest.

Bibliography

1. Practice Committee of the American Society for Reproductive Medicine. "The clinical relevance of luteal phase deficiency: A committee opinion". *Fertility and Sterility* 98.5 (2012): 1112-1117.

2. Mesen TB and Young SL. "Progesterone and the luteal phase: A requisite to reproduction". *Obstetrics and Gynecology Clinics of North America* 42.1 (2015): 135-151.

3. Stouffer RL., *et al*. "Endocrine and local control of the primate corpus luteum". *Reproductive Biology* 13.4 (2013): 259-271.

4. Coutifaris C., *et al*. "Histological dating of timed endometrial biopsy tissue is not related to fertility status". *Fertility and Sterility* 82.5 (2004): 1264-1272.

5. Usadi RS., *et al*. "Endometrial development and function in experimentally induced luteal phase deficiency". *Journal of Clinical Endocrinology and Metabolism* 93.10 (2008): 4058-4064.

6. Crawford NM., *et al*. "Prospective evaluation of luteal phase length and natural fertility". *Fertility and Sterility* 107.3 (2017): 749-755.

7. Palomba S., *et al*. "Progesterone administration for luteal phase deficiency in human reproduction: An old or new issue?" *Journal of Ovarian Research* 8 (2015): 77.

8. Miravet-Valenciano JA., *et al*. "Understanding and improving endometrial receptivity". *Current Opinion in Obstetrics and Gynecology* 27.3 (2015): 187-192.

9. Díaz-Gimeno P., *et al*. "The accuracy and reproducibility of the endometrial receptivity array is superior to histology as a diagnostic method for endometrial receptivity". *Fertility and Sterility* 99.2 (2013): 508-517.

10. Wang X and Yu Q. "An update on the progress of transcriptomic profiles of human receptivity". *Biology of Reproduction* 98.4 (2018): 440-448.

11. Jain M., *et al*. "Diagnosis of luteal phase defect by colour flow pulse Doppler". *Journal of Obstetrics and Gynecology of India* 57.4 (2007): 346-349.

12. Darland NW. "Infertility Associated with Luteal Phase Defect". *Journal of Obstetric Gynecologic and Neonatal Nursing* 14.3 (1985): 212-217.

13. Brown JB. "Types of ovarian activity in women and their significance: the continuum (a reinterpretation of early findings)". *Human Reproduction Update* 17.2 (2011): 141-158.

14. Usadi RS., *et al*. "Endometrial development and function in experimentally induced luteal phase deficiency". *The Journal of Clinical Endocrinology and Metabolism* 93.10 (2008): 4058-4064.

15. Schliep KC., *et al*. "Luteal Phase Deficiency in Regularly Menstruating Women: Prevalence and Overlap in Identification Based on Clinical and Biochemical Diagnostic Criteria". *The Journal of Clinical Endocrinology and Metabolism* 99.6 (2014): E1007-E1014.

Volume 8 Issue 6 June 2019