Research Article

To study the correlation of mid-cycle luteinizing hormone surge, endometrial thickness and blood flow with histopathological finding of premenstrual endometrial biopsy in patient undergoing evaluation for infertility

Pratiksha Gupta*, Chandana Shekhar

Department of Obstetrics and Gynecology, Post Graduate Institute of medical Sciences and research, New Delhi, India

*Correspondence:
Dr. Pratiksha Gupta,
E-mail: drpratiksha@gmail.com

ABSTRACT

Background: A prospective study of infertility evaluation: a comparison between premenstrual endometrial biopsy and mid-cycle non-invasive methods. A multicentre study in PGIMSR, GMCH, St stephens hospital, New Delhi, India.

Methods: women attending infertility clinics of age between 20-35 years, with regular menstrual cycles ranging from 21-35 days. Were included, a total of 120 women were enrolled. The study was performed with trans vaginal probe (6.5 MHz), at mid cycle on day 12-14, endometrial thickness was measured, with pattern and Doppler study to evaluate PI (Pulsatility index) and RI (Resistive index) of endometrial myometrial junction, with measurement of LH (Luteinising hormone) level at the same time. Assuming a minimum incidence of 6% with alpha = 0.05; power = 80% & dropout rate = 10% sample size is proposed to include 120 cases. Endometium sampling was done in premenstrual phase.

Results: The high level of LH correlated well with good secretory endometrium and patients with endometrial thickness ≥7 mm and a trilaminar pattern correlated well with secretory endometrium(in phase) and with ET <7 mm had out of phase or non-secretory endometrium. Among blood flow indices low (Pulsatility index) PI is seen to correlate with secretory endometrium. High blood flow impedance was detected in out of phase & non-secretory endometrium.

Conclusions: To conclude mid-cycle non-invasive methods are comparable to premenstrual endometrial biopsy for identification of patient with luteal phase defect.

Keywords: Endometrium, Infertility, Resistive index, Pulsatility index, Luteinizing hormone, Endometium sampling

INTRODUCTION

Infertility is inability to conceive within one year of unprotected regular intercourse.[1] 10-15 % of couples worldwide have infertility.[2]

Ovulation typically occurs 24 to 36 hrs after onset of LH surge & approximately 10 to 12 hrs after LH peak.[3-5] After ovulation, the remaining follicle cells forms corpus luteum, a regulator of luteal phase. Its function is dependent on the presence of LH. The corpus luteum secretes progesterone, that causes luteal transformation of endometrium.[1] Since progesterone production is a prerequisite to secretory transformation of endometrium and the maintenance of early pregnancy, normal function of corpus luteum is essential for successful human reproduction.[6] Abnormal function of corpus luteum, is an important cause of infertility and early pregnancy loss.[7] Luteal Phase defect (LPD) is diagnosed when two endometrial biopsy show a delay of more than two days

beyond the actual cycle day in the histologic development of the endometrium.[8] Although a luteal phase defect is a direct result of hormone production by corpus luteum; the underlying cause of this dysfunction are multiple.[3] These include abnormal LH pulse frequency and reduced bioactive LH, FSH during mid-cycle and decreased response of endometrium to progesterone. Luteal phase defect has been proposed as a cause of non-receptive endometrium. Receptivity of endometrium can be assessed by endometrial biopsy, its thickness & blood flow parameters. Impedance to the blood flow on Doppler depends on the phase of the menstrual cycle. Complex relation exist between hormones in peripheral blood during menstrual cycle & uterine artery blood flow parameters.[9,10] During normal cycle there is sharp increase in end diastolic velocity between the proliferative & secretary phase of menstrual cycle. Lowest blood flow impedance occurs at the time of peak luteal function; the time of implantation. In some infertile women end diastolic flow is not present. An endometrial biopsy is considered as gold standard of diagnosis. It is an invasive technique and may cause some discomfort to the patient and could potentially interrupt implantation in current implantation cycle. Ultrasonic analysis of endometrial thickness and blood flow are non-invasive techniques used for identification of patient with luteal phase defect. The objective of this prospective study is an attempt to establish a relationship between ultrasound appearance of the endometrial thickness, blood flow indices and the LH surge; with histologic dating by biopsy, for the assessment of luteal phase adequacy.

METHODS

This prospective study was conducted in the Department of Obstetrics & Gynecology, G.M.C.H and PGIMSR New Delhi, St Stephens hospital for two years from 2010 to 2013.Informed written consent taken from the women participating in the study. Total 120 subjects recruited in the study of age group 20 to 35 year undergoing infertility evaluation.

Study design

Prospective clinical study to assess the correlation between LH level, endometrial thickness & pattern and blood flow at day 14 with endometrial biopsy at day 21 of menstruation. The study group was divided into 3 groups depending on endometrial biopsy finding-Group1-Secretory Endometrium, group2-Luteal Phase defect, group3- Non-secretory Endometrium.

Study population

Patient attending infertility clinics from Jan 2010 to Dec 2013.

Sample size

Assuming a minimum incidence of 6% with alpha= 0.05; power= 80% & dropout rate= 10% sample size is proposed to include 120 cases.

Equipment

The study was performed with trans vaginal probe (6.5MHz).

Inclusion criteria

Age between 20-35 years, history of regular menstrual cycles ranging from 21-35 days.

Exclusion criteria

Age <20 years or >35 years, Cycle length <21to >35 days, presence of systemic disease, endometriosis, uterine or ovarian defect.

Women fulfilling the inclusion criteria were enrolled for the study. An informed written consent was taken from all enrolled patients, followed by detailed evaluation, which include history, general physical & gynecological examinations.

Women who are recruited for study had undergone all routine base line investigations. Clinical evaluation with detailed history was taken which included type of infertility with duration & duration of cohabitation. Relevant points in menstrual & obstetrical history. A patient past medical/surgical history was noted. Clinical examination including general physical & local examination was performed. Per abdomen, per speculum, per vaginal examination was also done. Relevant laboratory examination done if history & examination warranted.

On day 12th-14th of cycle serum LH level was estimated. 3 ml of blood collected from antecubital vein of the patient. The blood was allowed to clot for 2 hours at room temperature. The sera were separated after centrifugation at 3000 rpm for 10 minute. The sera was kept at -20^0c until analysed. LH was analysed using the principle of electro chemiluscence immunoassay technique. Trans Vaginal sonography was done on the same day of serum LH estimation. Patient lying in the dorsal position with leg semi flexed. On longitudinal view of uterus endometrial thickness measured as the maximum thickness between the highly refractive interface of endometrial-myometrial junction. The measurement included both layers of endometrium. Endometrial pattern was also noted. After completion of B mode examination a 6 MHz pulsed Doppler system was used for blood flow analysis. The blood flow velocity wave forms from sub endometrial vessels were obtained by placing the Doppler gate over the colour area and activating pulse Doppler function. A recording was considered satisfactory when at least five consecutive wave forms were obtained each demonstrating the maximum Doppler shift. Pulsatality index (PI) & Resistance index (RI) was calculated. All examination was performed by one investigator with same machine. Patients were called on day 21-22 of their cycle in the

department in the morning 8 am empty stomach. They were also advised to maintain abstinence in this cycle. After patient preparation endometrial curetting taken and sent for histopathological examination in formalin solution.

Statistical analysis

The data were presented in terms of mean & standard deviation for the non-invasive parameters (endometrial thickness, LH surge, blood flow) and the frequency (percentage) for qualitative variables such as biopsy. The correlation coefficient among non-invasive parameters was documented by Pearson correlation coefficient/nonparametric Spearman Rank correlation coefficient in case parameters do not follow normal distribution. The diagnostic indices (sensitivity, specificity, positive predictive value, negative predictive value, accuracy) of non-invasive parameters against histological biopsy as a gold standard. The measurements of agreement between invasive & non-invasive parameters were determined by measurement of agreement (kappa statistics) with its statistical significance by chai square test. The level of statistical significance was considered as P value less than or equal to 0.05 and the data was analysed using SPSS (statistic version 16) software.

RESULTS

A total of 120 women with infertility attending department of obstetrics & gynecology were recruited in the study. In present study age of female ranged from 21 to 35 years with Mean age as 27.65 ± 4.13. Out of them 70% (n=84) of recruited cases had primary infertility while secondary infertility seen in 30 % (n=36) of cases (Figure 1). In 71.7% (n=86) of women serum LH level was less than 20 mIU/ml while it was more than equal to 20 mIU/ml in 28.3% (n=34). Endometrial thickness was less than 7 mm in 58.3% (n=70) women and more than equal to 7 mm in 41.7% (n=50) of females undergoing evaluation endometrial morphology was trilaminar in 63% (n=76) females and poor trilaminar pattern seen in 36.7% (44) cases (Table 1).
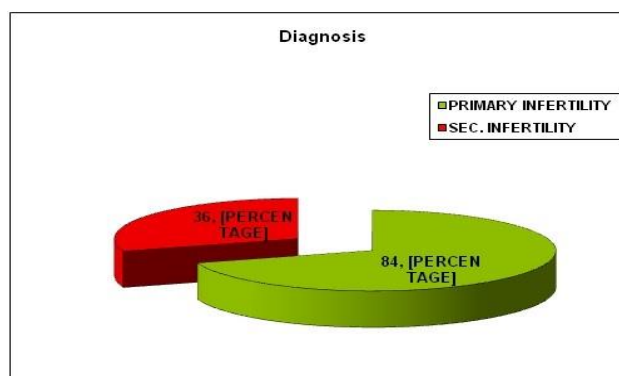
Table 1: LH Level, thickness of endometrium, trilaminar pattern of endometrium, histopathological types of endometrium.

LH level	Frequency	%
<20	72	72.0%
>=20	28	28.0%
Total	100	100%
Endometrial thickness	Frequency	%
<7	58	58.3%
>=7	42	41.7%
Total	100	100%
Pattern of endometrium	Frequency	%
Poor Tri	38	38.0%
Tri	62	62.0%
Total	100	100%
Endometrial biopsy	Frequency	%
Indequate	2	1.7%
LPD	34	35.0%
Nonsecretory	26	26.7%
Secretory	38	36.7%
Total	100	100%

Women undergoing infertility evaluation PI was in Less than 1 in 5% (n=6), while 25% (n=30) Patient had PI value 1-1.5, 15% (n=18) cases it was 1.6-2, 25% (n=30) 2.1-2.5 & in 30% (36) had values more than 2.5 (Figure 2, Table 2).
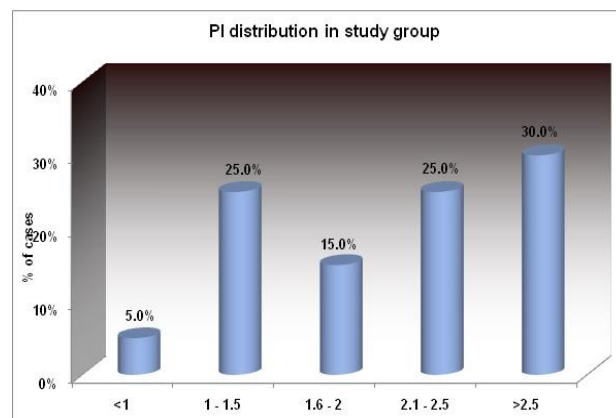

Figure 2: Distribution of PI (Pulsalitility index).

RI value was found less than 0.5 in 3.3% (n=4), while with RI values 0.5-1; 1.1-1.5; 1.6-2; more than 2 in were found in 60% (n=72), 23.3% (n=28), 11.7% (n=14), 1.7% (n=2) cases respectively.

Endometrial biopsy was found to be secretory in 36.7 % (n=44), non-secretory in 26.7% (n=32), and luteal phase defect in 35% (n=42) and in 2 patients sample was inadequate for evaluation. Among 34 pts with LPD, 36 (85.7%) had LH level less than 20 mIU/ml, while only 6 women had LH level more than equal to 20mIU/ml. LH level was less than 20 mIU/ml in all women with non-secretory endometrium while those with secretory

Figure 1: Distribution showing primary and secondary infertility.

endometrium 63.6% (n=28) had LH level more than equal to 20 miu/ml. LH level was less than 20mIU/ml in only 36.4% cases (n=16).
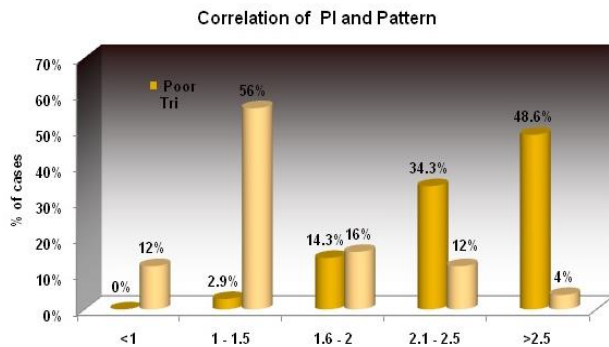

Figure 3: Correlation of PI and endometrium pattern.

Endometrial thickness (ET) was divided into 2 groups those with endometrial thickness less than 7 mm and other group with endometrial thickness ≥7 mm. 81% (34) of women with LPD had endometrial thin (<7 mm). Again in 93.8% (30) women with non-secretary endometrium had ET less than 7 mm. It is clearly evident from following cross table that 90.9 % women with secretary pattern had ET more than 7mm (Table 1).

Endometrial biopsy showed luteal phase defect in 42.9% case when PI value was between 2.1-2.5, while with nonsecretary pattern in 68.8 % case it showed PI value more than 2.5 (Table 2).

Similarly in Luteal phase defect RI was 0.5-1 in 61.9% while nonsecretary endometrium it was 43.8 %in women with RI between 1.6-2.

Table 2: Correlation of ET and Endometrial Biopsy, and Correlation of LH level and Endometerial Biopsy.

ET		Endomaterial Biopsy				P value
		INDEQU	LPD	NONSEC	SEC	
<7	Frequency	2	28	24	4	
	<7	100%	81%	93.8%	9.1%	<0.001
>=7	Frequency	0	6	2	34	
%	>=7	0%	19%	6.2%	90.9%	
Total		100	34	26	38	
LH Level						
<20	Frequency	2	30	26	14	
	<20	100%	85.7%	100%	36.4%	
>=20	Frequency	0	4	0	24	<0.001
%	>=20	0%	14.3%	0%	63.6%	
Total		100	34	26	38	

Table 3: Correlation of LH level and Endometrial pattern, and correlation of PI and Endometerial biopsy.

LH Level	Poor Tri		Tri		P value
	Frequency	Poor Tri	Frequency	Tri	
<20	38	100%	34	55.3%	
>=20	0	0%	28	44.7%	<.001
Total	38	100%	62	100%	

PI		Endomaterial biopsy				P value
		INDEQU	LPD	NONSEC	SEC	
<1	Frequency	0	0	0	6	
	<1	0%	0%	0%	13.6%	
1 - 1.5	Frequency	0	6	2	20	
%	1 - 1.5	0%	14.3%	6.2%	50%	
1.6 - 2	Frequency	0	8	0	8	
%	1.6 - 2	0%	23.8%	0%	18.2%	<.001
2.1 - 2.5	Frequency	0	14	6	2	
%	2.1 - 2.5	0%	42.9%	25%	9.1%	
>2.5	Frequency	2	6	18	2	
%	>2.5	100%	19%	68.8%	9.1%	
Total		100	34	26	38	

Poor trilaminar pattern was detected in 81.2% cases of nonsecretary endometrium and trilaminar pattern was found in all cases of secretary endometrium. In 61.9% cases with LPD trilaminar pattern seen.

LH level also correlated well with pattern of endometrium which was statistically significant. In all women with poor trilaminar pattern LH level was less than 20 mIU/ml. While value was more than equal to 20mIU/ml in all females with good trilaminar pattern (Table 3).

ET was less than 7 mm in all cases with poor trilaminar pattern and more than equal to 7 mm in 65.8% cases of trilaminar patter showing secretary activity (Table 4).

Table 4: Correlation of PI and Endometrial pattern, correlation of RI and Endometrial pattern and correlation of ET and Endometrial pattern.

	Poor Tri		Tri		P value
PI	**Frequency**	**Poor Tri**	**Frequency**	**Tri**	
<1	0	0%	4	12%	
1 - 1.5	2	2.9%	24	56%	
1.6 - 2	8	14.3%	8	16%	<0.001
2.1 - 2.5	20	34.3%	4	12%	
>2.5	28	48.6%	2	4%	
Total	58	100%	42	100%	
RI					
<0.5	0	0%	4	8%	
0.5 - 1	24	40%	36	88%	
1.1 - 1.5	24	40%	0	0%	<0.001
1.6 - 2	10	20%	0	0%	
>2	0	0%	2	4%	
Total	58	100%	42	100%	
ET					
<7	38	100%	8	34.2%	
>=7	0	0%	54	65.8%	<0.001
Total	38	100%	62	100%	

PI value of 1-1.5 in 2.9 %, 1.6-2 in 14.3%, 2.1-2.5 in 34.3% and more than 2.5 in 48.6% of women with poor trilaminar pattern. Further it is found that in 56 % women PI value was 1-1.5 which is statistically significant (Table 4).

RI was between 0.5-1 in 88% women with endometrium showing trilaminar pattern which is statistically significant (Table 4).

DISCUSSION

In present study group average age of women presented with infertility was 21-35 year with mean age of infertility being 27.65 +/-4.3. In present study serum LH less than 20mIU/ml was found in 71.7 % of cases and statistically significant correlation (P=0.001) was found between serum LH level and endometrial biopsy. In all cases the endometrium was lagged behind in growth by more than equal to 2days, indicating 87.5% luteal phase defect. While non-secretory endometrium was found in all women who had serum LH level less than 20mIU/ml.

On histology Secretory pattern of endometrium was found in 63.3% of women who had serum LH level more than equal to 20mIU/ml. It was further conclude that serum LH level on day 14 significantly correlated with endometrial thickness & pattern. In women having poor trilaminar pattern of endometrium, serum LH level was less than 20 mIU/ml which was statistically significant. While in women with good trilaminar pattern it was more than equal to 20 mIU/ml in 44.7% cases & 55.3% cases it was less than 20 mIU/ml. Endometrial thickness in present study it was less than 7 mm in 58.3% while poor trilaminar in 36.7% and good trilaminar in 63.3%. Endometrial thickness was less than 7 mm in 81% & 93.8% women showing luteal phase defect and non-secretory endometrium respectively while more than 7 mm in 90.9 % of women with secretory pattern. In all women having poor trilaminar pattern endometrial thickness was less than 7 mm while it was more than 7 mm in 65.8% women with trilaminar pattern showing sensitivity of 100%, specificity of 65.8%, positive predictive value of 62.9% and negative predictive value of 100%. Endometrial blood flow impedance in present

study was measured in terms of Pulsatality (PI) and resistance index (RI). In our study PI was <1, 1-1.5, 1.6-2, 2.1-2.5, & >2.5 in 5%, 25%, 15%, 25%, 30% of case respectively. RI was <0.5, 0.5-1, 1.1-1.5, 1.6-2 and >2 in 3.3%, 60%, 23.3%, 11.7%, 1.7 % of cases respectively. In 42.9 % cases of LPD (Luteal Phase defect), PI was between 2.1-2.5 showing poor vascularization of endometrium. In 68.8% women with non-secretory endometrium had PI more than 2.5.In 50 % of females with secretory pattern PI were between 1-1.5. All these values were statistically significant. RI was between 0.5-1 in 61.9% cases with LPD. With non-secretory endometrium this value was more than 2.5 in 43.8% women. 90.9% women with secretory endometrium had RI value between 0.5-1 suggestive of good endometrial vascularization. Trilaminar pattern was seen in 88% cases with RI 0.5-1, again suggestive of good vascularization of endometrium. With non-secretory endometrium poor trilaminar pattern was seen in 81.2% cases while in all cases of secretory endometrium only trilaminarpattern was seen in the study.

Strength and Limitations of the study was less sample size.

Globally according to WHO most infertile women suffer from primary infertility. But WHO estimates overall prevalence of infertility in India to be between 3.9 to 16.8%.[8] Prevalence in present study group is higher than reports from other Indian regions. Estimate of infertility vary widely among Indians. Moreover, the prevalence of primary infertility has also been shown to vary across tribes and castes within same region.

Similar result was found in one study of 847 patients who also found 100% correlation between LH surge and ovulation in clearplan home ovulation tests.[13] One WHO study involving 177 women stated that circulating LH is best parameter of impending ovulation and correlated well with endometrial thickness.[11-13]

Another study evaluated endometrial growth and texture using trans vaginal ultrasound, they found that increasing LH level correlated well with endometrial thickness and pattern. At ovulation there is maximum echogenic texture and thick endometrium.[11] similar findings were found in other studies.[13,14] Still another study evaluated the ability of histological dating to discriminate between fertile and infertile couples, according to this study the utility of histological dating of endometrium in the evaluation of infertile couples is uncertain.[15] Singh N, et al in their prospective studied evaluated the role of endometrial thickness, pattern & sub endometrial blood flow measured by 2D power Doppler ultrasound They concluded that thin endometrium with non-tripleline in IVF-ICS candidate cryopreservation was recommended and that vascularity has useful predictive value on the implantation rate in IVF cycle irrespective of morphological appearance of endometrium.[16]

In studies it was seen that endometrial and sub endometrial blood flow according to Doppler USG in women undergoing ART could not predict endometrial receptivity and IVF outcome.[17,18] Another study demonstrated that chances of pregnancy were more when endometrial thickness was more than 6 mm.[19] But one study in 1999 concluded that Doppler ultrasonographic evaluation of uterine blood flow and measurement of hormone concentration cannot be used to predict histological dating of an endometrial biopsy specimen obtained in a mid-luteal phase of a cycle.[20]

A study of 1509 patients the workers found no statistically significant difference between in phase and out phase endometrium with regard to patients age, endometrial thickness, or resistance index while pulsatality index was significantly higher in the in phase group. The overall predictive value of the study was 64% (sensitivity 57% & specificity 66%). Similarly another study failed to demonstrate any association between serum E_2, PI levels with hemodynamic response in uterine arteries & spiral arteries.[21]Another study observed that mean PI value of the uterine arteries demonstrated significant difference between left & right PI value & PI value of those who conceived and those who did not.[22]

In 2003 a study concluded that transvaginal ultrasound (TVS) to be good alternative tool in the assessment of endometrial receptivity and endometrial thickness & pattern. Similar result was found in another prospective study concluding colour Doppler to be an alternative non-invasive tool for diagnosing luteal phase defect.[22] Some worker have reported significant correlation between pregnancy rates &uterine artery Doppler flow while others have failed to demonstrate this.[23,24]

In present study high level of LH correlated well with good secretory endometrium and patients with endometrial thickness ≥7 mm and a trilaminar pattern correlated well with secretory endometrium (in phase) and with ET <7 mm had out of phase ornon secretory endometrium. Among blood flow indices low PI is seen to correlate with secretory endometrium. High blood flow impedance was detected in out of phase & non-secretory endometrium. Mid-cycle non-invasive methods are comparable to premenstrual endometrial biopsy for identification of patient with luteal phase defect.

CONCLUSIONS

High L H level may be taken as a surrogate marker of good corpus luteal activity resulting in a good secretory endometrium, Endometrial thickness more than 7 mm may be considered as receptive endometrium, Trilaminar endometrial pattern is also a surrogate marker of in phase secretory endometrium, Endometrial blood flow study (PI,RI) may be an alternative to endometrial biopsy.

REFERENCES

1. Decherney AH, Nathan L. Current obstetrics and gynaecology. 2003;979-991.
2. Berek JS. Infertility, Disorder of endometrial functiombcn and luteal phase defect, 14th edition Philadelphia; Lippincott. 2007;30:1186:180.
3. Sharif K. Advances in treatment of infertility. Bonnar, ed. Recent Advances in Obstetrics & Gynaecology. Churchill Livingston. 2001:141-56.
4. Merck A F, Speroff L, Clinical gynaecology endocrinology, Female infertility, 8th edition. 2011;27:1157.
5. Strauss JF, Yen. Jaff's Reproductive endocrinology, Female infertility 6th edition, Philadelphia. 2009;21:521.
6. Jones GES. Some newer aspect of management of infertility. JAMA. 1949;141:1123.
7. Merck AF, Speroff L. clinical gynaecology endocrinology, Female infertility, 8th edition. 2012;10:390-1.
8. Hormeyr GJ, Jaff MI, Bezwado WR. Immunologic consequances of recurrent pregnancy loss and consequances of immunization with husbands leukocytes. Fertil Steril. 1987;48:681-4.
9. Goswamy RK, Williams G, Steptoe PC. Decreased uterine perfusion a cause of infertility. Huma Repro. 1988;3:955-9.
10. Fluker M, Fisher S. Adult reproductive endocrinology, anovulation & ovulatory dysfunction. 2007;277-88.
11. Bakos O, Lundkvist O. Bergh The human reproduction. 1993:8(6):799-806.
12. Probit analysis. World Health Organization, Task Force on Methods for the Determination of the Fertile Period, Special Programme of Research, Development and Research Training in Human Reproduction. Am J Obstet Gynecol. 1980;138(4):383-90.
13. Guida M, Tommaselli GA, Palomba S, Pellicano M, Moccia G, Di Carlo C, et al. Efficacy of methods for determining ovulation in a natural family planning program. Fertil Steril. 1999;72(5):900-4.
14. Quintero RB, Sharara FI, Milki AA. Successful pregnancies in the setting of exaggerated endometrial thickness. Fertil. Steril. 2004;82(1):215-7.
15. Coutifaris C, Myers ER, Guzick DS, Diamond MP, Carson SA, Legro RS, et al. NICHD National Cooperative Reproductive Medicine Network. Histological dating of timed endometrial biopsy tissue is not related to fertility status. Fertil Steril. 2004;82(5):1264-72.
16. Aghahoseini M, Tuba K, Marsousi V, Aleyasin A. Assessment of endometrial-subendometrial blood flow detected by color doppler sonography and uterine receptivity in infertile women. Acta Medicaa Iranica. 2008;46(6):461-6.
17. Singh N , Bahadur A, Mittal S , Malhotra N, Bhatt A, Predictive value of endometrial thickness, pattern and sub-endometrial blood flows on the day of hCG by 2D doppler in in-vitro fertilization cycles: A prospective clinical study from a tertiary care unit J Hum Reprod Sci. 2011;4(1):29-33.
18. Moradan S. Assessment of the relationship between endometrial thickness and number of dominant follicles in pregnancyrate among 361 intrauterine insemination cases. http://www.koomeshjournal.ir/browse.php?a_code=A-10-4-222&slc_lang=en&sid=1&ftxt=1.
19. Habibzade V, Noureddin S, Mahani N, Kamyab H. The correlation of factors affecting the endometrial thickness with pregnancy outcome in the IUI cycles Iranian Journal of Reproductive Medicine. 2011;9(1):41-6.
20. Markus AS, Grab D, Schneider V, Strehler E. Predicting the histologic dating of an endometrial biopsy specimen with the use of Doppler ultrasonography and hormone measurements in patients undergoing spontaneous ovulatory cycles Fertility And Sterilityt. 2000;73(1).
21. Dal J, Vural B, Caliskan E, Ozkan S, Yucesoy I. Power Doppler ultrasound studies of ovarian, uterine, and endometrial blood flow in regularly menstruating women with respect to luteal phase defects. 2005;84(1):224-7.
22. Yalti S, Gürbüz B, Ficicioglu C, Canova H. Doppler evaluation of the uterine, intraovarian, stromal and spiral arteries on the day of human chorionic gonadotrophin administration in controlled ovarian hyperstimulation. J Obstet Gynaecol. 2003;23(4):402-6.
23. Elnashar AM, Aboul-Enein GI. Benha and Zagazig University Hospitals, Endometrial receptivity Middle East Fertility Society Journal. 1995;10(4):919-22.
24. Birol V. Power Doppler studies of ovarian, uterine and endometrial blood flow in regularly menstruating women with respect to LPD, Fertil Steril. 2005,84:224-7.