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Evaluation of Uterine Receptivity in Cases of IVF/ICSI Programs

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SUMMARY

Background: Endometrial receptivity is an important factor that determines the success of embryo implantation; however, an appropriate method of assessing endometrial receptivity has not been well identified. We attempted to determine it via ultrasonographic evaluation of endometrial thickness/ pattern as well as Doppler study of uterine artery blood flow.

Methods: We studied 100 women who underwent *in vitro* fertilization (IVF) and/or intracytoplasmic sperm injection (ICSI). Endometrial thickness/ pattern, pulsutility index (PI), and estradiol level were calculated and related to pregnancy and embryo implantation rate.

Results: Endometrial thickness ≥ 8 mm was associated with good pregnancy rate (30.8%); thin endometrium (<7.9 mm) is usually associated with implantation failure. Endometrial thickness has a high sensitivity and negative predictive value (92.3; 90.9%, respectively) with low specificity and positive predictive value (27.0; 30.8%, respectively) for predicting pregnancy. High pregnancy rate was reported with triple layered endometrium (multilayered type) in comparison to other endometrial pattern: no pregnancy occurred with hyperechoic endometrium (non-multilayered type); A multilayered endometrial pattern has 100% sensitivity and negative predictive value but, the specificity and positive predictive value remain low (40.5; 37.1%, respectively). Combination of endometrial thickness and pattern increased the specificity and positive predictive value (48.6; 38.7%, respectively) but they are still unsatisfactory. Embryo implantation and pregnancy rate were higher in cases with low PI (< 3); but without significance.

Conclusion: Endometrial thickness and pattern had high sensitivity; however, neither endometrial thickness nor pattern is specific enough for pregnancy prediction. Doppler is neither sensitive nor specific to pregnancy prediction.

Keywords: Pregnancy rate; *In vitro* fertilization; Intracytoplasmic sperm injection

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INTRODUCTION

Endometrial receptivity means the time in which the endometrium allow implantation. Implantation has been defined as the adhesion or fixation of blastocyst to the endometrial surface of the uterus. Successful implantation is dependent upon the embryo being at correct stage of development (development window), with the endometrium synchronously reaching the receptive stage (receptive window). In assisted conception terms, the correct timing for the two coming into contact dictates the optimum time for embryo transfer (transfer window) [1].

The success rates of *in vitro* fertilization (IVF) and associated technique are still disappointing; with an overall live birth rate per cycle only 20%. The most likely stage for a cycle of IVF or IVF/ intracytoplasmic sperm injection (ICSI) to fail is following embryo transfer. Despite 85% of treatment cycles reaching the stage of embryo transfer, only 23% become clinical pregnancies, indicating failed implantation in three out of four embryo transfers [2].

The human endometrium is an extremely sensitive target for steroid hormones. During the menstrual cycle; this tissue undergoes dynamic changes that are reflected on the surface morphology of the epithelium and that can be followed by scanning microscopy. The morphological changes peak at the mid- secretory phase, with the formation of the so- called pinopodes. Increasing evidence suggests that these pinopodes are accurate markers for endometrial receptivity, and their detection may be of high clinical utility in the preparation of the endometrium before embryo transfer [3].

Two ultrasonographic measurements have been proposed for assessment of endometrial receptivity, assessment of endometrial appearance (thickness and pattern) and endometrial vascularization by pulsed Color Doppler ultrasonography [4].

Although it is well known that there are multiple factors that influence successful implantation, there is much debate regarding the relationship of endometrial thickness and morphology to successful implantation in IVF programs. Many teams have reported significant correlation between pregnancy rate, endometrial thickness and morphology as defined by ultrasonography [5].

With regard to uterine artery blood flow in stimulated cycles, equally controversial conclusions have been reached. Some researches have reported significant correlations between pregnancy rate and uterine artery Doppler blood flow values [6]. Non uniform conclusions have been reported in different studies. These contradictory results

were the impetus that led us to conduct this work.

This work was designed to assess the implantation potential in women undergoing IVF and / or ICSI program by:

1. Ultrasound evaluation of endometrial thickness and pattern.
2. Doppler ultrasonographic study of uterine artery blood flow.

MATERIALS AND METHODS

This study was carried out in a University Hospital during the period from November 2019 to November 2020.

Subjects

The study included a total of 100 infertile women of those attending the assisted reproduction technology (ART) unit. They were scheduled to undergo ovarian stimulation and either IVF or ICSI therapy.

Inclusion criteria

All patients fulfilled the following inclusion criteria: (1) Age less than 37 years, (2) A history of infertility either primary or secondary, (3) Normal hysteroscopic findings, (4) Satisfactory basal ultrasound examination and (5) All patients had a normal serum follicle stimulating hormone (FSH) level (< 10 IU/ L) on day 3 of the menstrual cycle at least not more than 3 months before the procedures.

Exclusion criteria

(1) Age 37 years, (2) Causes of infertility that decrease the endometrial receptivity such as hydrosalpinx and endometriosis, (3) Local endometrial abnormalities such as: submucous fibroid, intrauterine adhesions, endometrial hyperplasia, endometrial polyp and Mullerian fusion defects, (4) A history of hysteroscopic or open uterine surgery with deformed cavity, (5) Poor ovarian response and (6) Cases with no embryo transfer either due to failed fertilization or high risk of hyperstimulation syndrome development.

All the patients that fulfilled the inclusion criteria were further subdivided into two groups according to the occurrence of pregnancy:

Group 1: Pregnant group included 26 women with mean age (± SD) was [27.92 ± 4.32 years], 84.6% had primarily infertility, 15.4% had secondary infertility, 23.1% underwent ICSI and 76.9% underwent IVF.

Group 2: Non-pregnant group, included 74 women with mean age (± SD) was [31.56 ± 4.03 years], 91.9% had primarily infertility, 8.1% had secondary infertility, 43.2% underwent ICSI and 56.7% underwent IVF.

The following data was recorded for each cycle: Time of procedure, Type of trial, Duration of treatment, Used protocol, Drugs received (type and dose), Ovarian response, Number of oocytes retrieved, Number of fertilized oocytes, Number of embryo transferred to the uterus and the results and History of any complication with the trial such as cancellation of the procedures either due to poor response or risk of development of ovarian hyperstimulation syndrome.

Ovarian hyperstimulation, oocytes retrieval and embryo transfer

1. All patients with satisfactory ultrasound examination examination started the ovarian stimulation protocol according to the long protocol.
2. The gonadotrophin releasing hormone (GnRH) agonist buserelin acetate (suprefact; Hoechst, Hounslow, United Kingdom) was administered subcutaneously at a daily dose of 500 ug starting in the midluteal phase of the cycle preceding stimulating one and was continued for 12 - 14 days till the onset of menstruation.
3. Down regulation was regarded as satisfactory when ultrasound examination performed on the 2nd or 3rd of the stimulating cycle and revealed thin endometrium (< 5 mm), no ovarian cysts, or any follicle more than 10 mm and serum E2 was < 50 pg / ml.
4. Subsequently, controlled hyperstimulation was then initiated with FSH and / or hMG in appropriate doses according to the age of the patient, FSH level and ovarian volume.
5. All patients underwent serial transvaginal ultrasonographic assessment of follicular growth until three or more follicles with a mean follicular diameter 18mm were seen.
6. At this stage 10.000 IU of human chorionic gonadotrophin (hCG) (pregnyl: organon, Oss, The Netherlands) were administered to induce final oocyte maturation and ovulation.
7. Serum estradiol (E2) levels were assayed on the day of hCG administration as follows:

- Blood sample by venous puncture about 3ml of blood withdrawn in sterile tube.
- Serum was collected after clotting and centrifugation
- The serum was kept at –20°c until analyzed.
- Estimation of E2 was done on Vidas analyzer (Bio Merieux) using enzyme linked fluorescence assay method.

8. Oocytes were retrieved by transvaginal ultrasound-guided follicular aspiration 34- 36 hours after hCG administration.
9. After aspiration, oocytes were screened, incubated, then either inseminated after 4-6 hours or injected according to the planning procedures, (IVF or ICSI) and according to semen quality.

IVF was done in cases with good semen parameters (in the number, motility and abnormal form in which, number must be more than 20 million, with more than 50% grade a+b motility or more than 25% grade a motility and abnormal form less than 50%) according to normal values of semen analysis (WHO 1999). ICSI was done in cases with poor semen quality either in the form of oligospermia, athenospermia, teratospermia, or azoospermia.

10. The inseminated or injected oocytes were examined after 18 hours for detection of evidence of fertilization.

Ultrasound investigations

On the day of but before the injection of hCG, transvaginal ultrasound examination using a 5 MHz transvaginal transducer with Color and Pulsed Doppler facilities (TOSHIBA - model, SSA - 270 A / HG Tokyo, Japan) was performed. Ultrasound examination included evaluation of endometrial appearance as well as assessment of uterine hemodynamics the pulsatility index was measured.

RESULTS

Transvaginal color and pulsed Doppler assessment of uterine artery blood flow was performed on 100 cases undergoing IVF or ICSI cycles during the study period after exclusion of cases with failed fertilization, cases with only one embryo available for transfer and cases with high risk for developing OHSS.

The overall pregnancy rate was 26% (26/ 100) including 2 biochemical pregnancy, 6 clinical pregnancy miscarriages, 16 singletons and 2 sets of twin. There is no significant differences between pregnant and non-pregnant groups as regard to type of infertility (either primary or secondary), previous trial (previous IVF or ICSI), parity (either delivered before or not), and causes of infertility after exclusion of causes that lower the incidence of embryo implantation (endometriosis, hydrosalpinx and submucous fibroid). Also as regard body mass index, FSH level before induction, the total number of hMG ampoules, day of hCG administration, number of follicles aspirated, the number of viable oocyte collected, embryos quality or number of transferred embryos. However, the number of fertilized oocytes was significantly high in the pregnant compared with non-pregnant groups.

There was no significant difference in mean (± SD) uterine artery pulsatility index between pregnant and non-pregnant groups (2.40 ± 0.52 *vs.* 2.35 ± 0.59 respectively; $p > 0.05$). The mean uterine pulsatility index was divided into 2 ranges (low, 1.00 to 2.99 and high 3.00). The pregnancy and implantation rates were calculated for each group (**Tab. 1**.).

Pregnancy rate was defined as the proportion of women having a positive pregnancy test 2 weeks after ET. Embryo implantation rate was defined as the proportion of gestational sacs to embryos transferred into the uterus.

Although pregnancy rate was high in those with low uterine artery pulsatility (1.00 to 2.99) the difference compared with the other group (high pulsatility index 3) was not statistically significant (27.2% *vs.* 20% respectively; $p > 0.05$) (**Tab. 2**.). Also, the embryo implantation rate in those with low uterine artery pulsatility index (1.00 to 2.99) was higher when compared with those with high pulsatility index (3) the difference was statistically not significant, (10.2% *vs.* 6.8% respectively; $p > 0.05$). There is no significant difference in semen quality between both groups (**Tab. 3.**).

The mean (± SD) E2 concentration for low and high pulsatility index group was statistically not significant

Tab. 1. Demographic data between pregnant and non-pregnant study groups.

Study Group / Demographic Data	Pregnant (N=26)		Non-pregnant (N=74)		Test of Significant	P Value
Age (X ± SD)	27.92 ± 4.32		31.56 ± 4.03		t = 2.74	< 0.01
< 30 (n %)	18	47.4	20	52.6	Fisher exact test	< 0.01
>30 (n %)	8	12.9	54	87.1	-	-
BMI						
20-25 (n %)	14	36.8	24	63.1	Fisher exact test	> 0.05
25-29.9 (n %)	8	30.8	18	69.1	-	> 0.05
≥30 (n %)	4	11.1	32	88.9	t = 2.38	> 0.05
Duration of Infertility						
(X ± SD)	7.23 ± 2.61		10.13 ± 4.09		Fisher exact test	< 0.05
Type of Infertility						
Primary (n %)	22	24.4	68	75.6	Fisher exact test	> 0.05
Secondary (n %)	4	40.0	6	60.0	-	-
Parity						
-ve (n %)	22	24.4	68	75.6	Fisher exact test	> 0.05
+ve (n %)	4	40.0	6	60.0	-	-
Previous Trial						
0 (n %)	22	30.6	50	69.4	Chi-squares	> 0.05
1 (n %)	4	22.2	14	77.8	2.75	> 0.05
2 (n %)	0	0.0%	10	100.0	-	> 0.05
Laparoscopic Finding						
-ve (n %)	10	17.2	48	82.8	-	> 0.05
+ve (n %)	16	38.1	26	61.9	-	-

Tab. 2. Distribution of the different causes of infertility in both study groups.

Causes of Infertility	Pregnant		Non-pregnant		Test of Significant	P Value
	N	%	N	%		
Tubal causes (n =28)	8	28.6	20	71.4	Fisher exact test	> 0.05
An Ovulation						
(n =18)	8	44.4	10	55.6	Fisher exact test	> 0.05
Male Factor						
(n = 38)	6	15.8	32	84.2	Fisher exact test	> 0.05
Unexplained						
(n =16)	4	25.0	12	75.0	Fisher exact test	> 0.05

Tab. 3. Semen quality in the two study groups.

Semen Quality	Pregnant (N=26)		Non-pregnant (N=74)		Test of Significant	P-Value
	N	%	N	%		
Good quality (n = 60)	18	30.0	42	70.0	Fisher exact test	> 0.05
Oligospermia (n = 26)	2	7.7	24	92.3	Fisher exact test	> 0.05
Teratospermia (n = 2)	2	100.0	0	0.0	Fisher exact test	> 0.05
Athenospermia (n =10)	5	40.0	6	60.0	Fisher exact test	> 0.05
Azoospermia (n = 2)	0	0.0	2	100	Fisher exact test	> 0.05

(2285.0 ± 808.4 *vs.* 2017.3 ± 939.4 pg/ ml respectively; p > 0.05). As regard to endometrial thickness, there was significant difference in mean (± SD) endometrial thickness between pregnant and non-pregnant groups; (10.66 ± 1.52 *vs.* 9.37 ± 1.98 respectively; p < 0.05). Also, pregnancy rate in those with multilayered endometrial pattern was significantly higher when compared with those with non-multilayered endometrial pattern (37.1% *vs.* 0.0% respectively; p < 0.05) (**Tab. 4-7.**).

As shows in the **Tab. 8.** there is no significant difference in E2 level between low and high pulsatility index groups. Ovarian stimulation day of h CG, number of stimulated follicles, retrieved oocytes and fertilized oocytes (**Tab. 9.**) and Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of different predictors of uterine receptivity (**Tab. 10.**).

DISCUSSION

In this study, all the factors that affect the endometrial receptivity such as endometriosis, hydrosalpinx, submucous fibroid and any abnormality of the uterine cavity were excluded. Furthermore, there was no significant difference between both study groups regarding to stimulation protocol, day 3 serums FSH level, days of hMG stimulation, number of stimulated follicles, number of mature oocytes retrieved and number of embryo transferred as well as embryo quality. This may exclude the possible implication of oocyte and embryo quality as the main contributing factors to the outcome which shift the focus of this study to uterine receptivity as the main principle determinant of treatment outcome.

In the present study, thin endometrial lining was associated with significant lower pregnancy rates. The mean endometrial thickness in pregnant patient was 10.66 ± 1.52; while in non-pregnant was 9.37 ± 1.98, the difference was statistically significant. The minimum endometrial thickness in pregnant group was 7.9 mm and the maximum endometrial thickness was 13 mm in the same group.

Similar observations were reported by Ariel, who described that thin endometrium (less than 7 mm) in the periovulatory period measured by transvaginal ultrasonography has been correlated with decreased clinical pregnancy rates [7].

On the contrary, De Geyter C, et al. [8] stated that reduced endometrial thickness has only a marginal effect on probability of achieving a pregnancy with assisted reproduction. Consequently, they do not recommend the cryopreservation of all oocytes or embryos or even the cancellation of treatment cycles in patients who have a thin endometrium.

In the present study endometrial thickness has a high sensitivity and negative predictive value with low specificity and positive predictive value for predicting of pregnancy. So it can be safely concluded that, it is not possible to predict the probability of pregnancy with endometrial thickness alone. These results are in agreement with those carried by Gonen Y and Casper RF [9], who reported that the positive predictive value of endometrial thickness alone is low, but a threshold value of < 6 mm has great negative predictive value for the occurrence of pregnancy.

In the current work, there is a statistically significant difference between pregnant and non-pregnant as regard to endometrial pattern. Pregnancy rate of 37% was reported for cases with triple endometrial line. All cases in pregnant groups had triple layered endometrium, while, no pregnancy occurred in hyperechoic endometrium (non-multilayered type).

Tsai and his-coworkers, evaluated the prognostic value of the endometrial sonographic pattern on the day of human chorionic gonadotrophin administration. The endometrial sonographic pattern was classified as (A) homogenous, hyperechogenic; (B) intermediate, iso-echogenic and (C) multiple-layered 'triple-line. In which type A had no pregnancies, whereas type B had a 20% fecundity rate and type C had a 21% fecundity rate. The continuing pregnancy rate was 10% in type B, as compared to 19.3% in type C [10].

Tab. 4. Endometrial thickness and pulsatility index among the study group.

Study Group / PI & Endometrial Thickness	Pregnant (N = 26)	Non-pregnant (N = 74)	T- Value	P Value
Pulsatility index (X ± S.D)	2.40 ± 0.52	2.35 ± 0.59	t = 0.26	> 0.05
Endometrial thickness (X ± S.D)	10.66 ± 1.52	9.37 ± 1.98	t = 2.12	< 0.05

Tab. 5. Frequency distribution and percentage of both groups regard endometrial thickness, PI and endometrial pattern.

Study Group / Endometrial Thickness, Pattern and PI	Pregnant N	Pregnant %	Non Pregnant N	Non Pregnant %	Test of Significant	OR 95% C.I	P Value
Endometrial Thickness							
< 8 mm (n =22) (n %)	2	9.1	20	90.9	t = 2.12	4.34	< 0.05
≥ 8 mm (n = 78) (n %)	24	30.8	54	69.2	-	-	-
Pulsatility Index							
< 3 (n = 80) (n %)	22	27.2	58	72.0	Fisher exact test	1.52	> 0.05
≥ 3 (n = 20) (n %)	4	20.0	16	80.0	-	-	-
Endometrial Pattern							
* Multilayered, (n = 70) (n %)	26	37.1	44	62.9	Fisher exact test	Undefined	< 0.01
* Non-multilayered (n = 30) (n %)	0	0.0	30	100.0	-	-	-

Tab. 6. Pregnancy and embryo implantation rate regard endometrial pattern.

Study Group / Pregnancy & Embryo Implantation Rate	Multilayered (N=70)		Non-multilayered (N = 30)		P Value
** Pregnancy rate (n %)	26	37.1	0	0.0	< 0.01
**Embryo implantation rate (n %)	13	13.5	0	0.0	< 0.01

Tab. 7. Pregnancy and embryo implantation rate regard uterine artery PI.

PI / Pregnancy & Embryo Implantation Rate	PI < 3 (N = 80)		PI ≥ 3 (N = 20)		O.R 95% C.I	P Value
** Pregnancy rate (n %)	22	27.5	4	20.0	1.52 (0.24- 16.7)	> 0.05
**Embryo implantation rate (n %)	22	10.2	4	6.8	1.53 (0.30- 15.0)	> 0.05

Tab. 8. Mean estradiol level in relation to pulsatility index.

PI / E2	PI < 3 (X ± SD)	PI ≥ 3 (X ± SD)	T value	P value
E2	2285.0 ± 808.4	2017.3 ± 939.4	T = 0.91	> 0.05

Tab. 9. Ovarian stimulation (duration and number of h MG ampoules), day of HCG, number of stimulated follicles, retrieved oocytes and fertilized oocytes.

Variables	Pregnant (N = 26)	Non-pregnant (N = 74)	t Value	P Value
- Number of hMG ampoules	50 ± 6.7	50.2 ± 6.8	0.12	> 0.05
- Day of h CG administration	14.1 ± 1.89	13.5 ± 2.1	0.9	> 0.05
- Number of stimulated follicles	8.23 ± 2.04	8.75 ± 2.24	0.74	> 0.05
- Number of retrieved oocytes	7.38 ± 2.36	6.54 ± 2.81	0.96	> 0.05
- Number of fertilized oocytes	5.61 ± 1.44	4.18 ± 1.52	2.93	< 0.05
- Number of embryo transfer	2.69 ± 0.48	2.65 ± 0.48	0.28	> 0.05

Tab. 10. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of different predictors of uterine receptivity.

Variables	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Accuracy
Endometrial thickness ≥ 8 mm	92.30%	27.00%	30.80%	90.90%	44%
Pulsatility index < 3	76.90%	21.60%	25.60%	72.70%	36%
Endometrial pattern (multilayered type)	100%	40.50%	37.10%	100.00%	56%
Endometrial thickness and pattern (multilayered ≥ 8 mm)	92.30%	48.60%	38.70%	94.70%	60%
Endometrial pattern, thickness and pulsatility index (multilayered ≥ 8 mm and < 3 index)	76.90%	64.90%	43.50%	88.90%	68%

In the present work, the endometrial sonographic pattern were classified as non- multilayered type, and multilayered type. In which multilayered endometrial pattern have 100% sensitivity and negative predictive value for prediction of pregnancy but the specificity and positive predictive value remain low. Combination of endometrial thickness and pattern has led to increase in the specificity and positive predictive value but they are still unsatisfactory. These results are in harmony with those carried by Gonen Y and Casper RF [9], who reported that the a multilayered

triple-lined line endometrium was claimed to be associated with the high implantation rates compared with other patterns, and the positive predictive value of endometrial thickness alone is low, but a threshold value of < 6 mm has great negative predictive value for the occurrence of pregnancy [10].

An accurate method of assessing endometrial receptivity has not been identified. The standard method of endometrial dating, histologic analysis of an endometrial biopsy specimen, cannot be used in treatment cycles. Therefore, non-invasive methods such as blood flow measurements have been studied by numerous investigators. Most of them have focused preferentially on uterine artery blood flow measurements since these vessels could be easily recognized and studied [11].

In the present work the role of transvaginal ultrasonography as well as color and pulsed Doppler examination of uterine vasculature in infertile patients treated by IVF and ICSI programs were studied. Color and pulsed Doppler study was performed when vaginal ultrasonography demonstrate optimum diameter of the leading follicle on the day of but before the administration of hCG to determine whether assessment of uterine artery blood flow at this stage has any prognostic value as regard to pregnancy and implantation.

For quantitative purposes, the pulsatility index (PI) became widely used because of its accurate reflection of blood flow impedance and because its calculation is also possible under adverse flow conditions such as absent or reversed end diastolic flow [12].

In this study, there is no significant difference in uterine artery pulsatility index between pregnant and non-pregnant group (2.40 ± 0.52 *vs.* 2.35 ± 0.59 respectively; $p > 0.05$). Although embryo implantation rate in those with uterine artery pulsatility index < 3.00 was higher than those who had a uterine pulsatility index 3.00, the difference was statistically non-significant (10.2% *vs.* 6.8% ; $p > 0.05$). Also, pregnancy rate tended to be higher in patients with PI < 3 than those who had a uterine pulsatility index 3.00, but the difference did not touch the significant level (27.2% *vs.* 20% respectively; $p > 0.05$). Furthermore, the predictive value of using a PI value < 3 in assessing uterine receptivity seems to be limited (72.7% negative predictive value and 76.9% sensitivity with low specificity and positive predictive value). This could be attributed to passage of most uterine blood flow to the myometrium, which represent the main compartment of the uterus not to the endometrium, which represent the site of implantation. This can be further supported by the absence of significant negative correlation between uterine artery PI and endometrial thickness.

These results are in agreement with those carried by Favre and his-coworkers, who failed to find any correlation between pregnancy rate and uterine artery pulsatility index in IVF cycles [13].

In this study, the negative correlation between uterine artery pulsatility index and E2 level in the pregnant group at the day of hCG administration was statistically not significant. However, De Ziegler D, et al. [14] stated that Doppler studies in young women with primary ovarian failure and postmenopausal women receiving hormonal replacement therapy had shown that small amounts of E2 are enough to reduce substantially uterine artery pulsatility index, thus leading to the conclusion that supraphysiological E2 concentration could not further reduce impedance.

To sum up, for an embryo to implant the quality of the endometrium may be more important than the global uterus. In this study, individual sonographic and Doppler parameters were found to be of insufficient accuracy to predict uterine receptivity. Thus, studies to evaluate intra-endometrial vascularity in order to analyze the flow that is truly representative of endometrial condition may allow further insight into uterine receptivity. Furthermore, implantation in humans is a complex process that involves embryo apposition and attachment to the maternal endometrial epithelium, transferring adjacent cells of the epithelial lining and invasion into the endometrial stroma. These processes involve a variety of molecules which are not unique in themselves, but play unique roles in the process of implantation. Therefore, studies of the chemical mediators involved in the process of implantation as well as markers for embryo quality are needed to be developed and combined with ultrasound findings to enhance the specificity of these tools in predicting implantation.

Although this study did not introduce new findings, the presented data may add some value to the current literature as some previously reported findings have been confirmed by the current work. First, a significantly lower pregnancy rate is associated with thin endometrium although there is no agreement on a cutoff value at which a favorable outcome may be expected. Second, the probability of pregnancy cannot be predicted with endometrial thickness alone. Third, the endometrial sonographic pattern on the day of human chorionic gonadotrophin administration may have a prognostic value to the extent that combination of endometrial thickness and pattern has led to increase in the specificity and positive predictive value in predicting pregnancy but they are still unsatisfactory. Last, the predictive value of uterine artery blood flow assessment as regard to pregnancy and implantation seems to be limited.

Based on the current findings, studies to evaluate intra-endometrial vascularity as well as sub-endometrial perfusion are recommended to allow further insight into uterine receptivity. Also, studies of the chemical mediators involved in the process of implantation as well as markers for embryo quality in combination with ultrasound findings are recommended to enhance the specificity of these tools in predicting implantation.

CONCLUSION

Endometrial thickness and pattern have high sensitivity; yet, neither endometrial thickness nor pattern is specific enough for prediction of pregnancy. Doppler echography is an interesting tool for assessing uterine receptivity;

however, color Doppler study of uterine artery blood flow (PI) is neither sensitive nor specific to predict the like hood of pregnancy. The pregnancy rates of assisted reproductive procedures are influenced only marginally by the uterine artery blood flow value (PI) and treatment should not be canceled because of its high value.

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