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ORIGINAL ARTICLE

The usefulness of endometrial thickness, morphology and vasculature by 2D Doppler ultrasound in prediction of pregnancy in IVF/ICSI cycles

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Abstract *Objective:* The aim of this study was to assess the predictive value of endometrial thickness, morphology and vasculature using two-dimensional (2D) Doppler ultrasound on the IVF/ICSI cycle outcome.
Subjects and methods: Endometrial thickness, morphology and subendometrial blood flow were assessed using transvaginal ultrasound on the day of hCG in 100 patients undergoing IVF/ICSI treatment in the period between June 2013 and January 2015. Statistical analysis was done.
Results: There was no difference in the demographic features or details of ovarian stimulation between pregnant and non-pregnant women. Overall, 40 patients conceived; 23 (57.5%) of them had blood flow in zone III and 15 (37.5%) in zone II. All patients achieved pregnancy had endometrial thickness >8 mm. Using the ROC curve, the cutoff endometrial thickness for non-achieving pregnancy was 7 mm with a sensitivity and specificity of 100%. There was no significant difference in Doppler indices between pregnant and non-pregnant women.
Conclusion: When the endometrial thickness is <8 mm, and if there are non-triple endometrial line and non-favorable blood flow zone on day of hCG in IVF/ICSI cycles, pregnancy is unlikely and embryo transfer should be canceled with freezing of all embryos for future transfer to increase the success rate.

1. Introduction

Successful implantation requires good harmony between the endometrium and blastocyst (1). Ultrasound examination of

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the endometrium is a commonly used non-invasive tool to assess endometrial receptivity during IVF treatment. A good blood supply to the endometrium is an essential requirement for implantation and assessment of endometrial blood flow in IVF treatment has attracted a lot of attention in recent years (2).

Doppler study of uterine arteries does not reflect the actual blood flow to the endometrium. Endometrial and sub-endometrial blood flows can be more objectively and reliably measured with three-dimensional power Doppler ultrasound. However, their role in the prediction of pregnancy in IVF treatment reported a conflicting result (3,4).

The study of endometrial thickness, pattern, volume, Doppler and sub-endometrial blood flow by ultrasound has been used to assess endometrial receptivity during IVF treatment. The measurement of endometrial blood flow as a physiologic dimension in addition to the anatomic parameters gained by the ultrasound had played an important role in the expectation of pregnancy outcome in IVF/ICSI cycles (1,4,5). So, endometrial receptivity is essential to implantation of an embryo and ultrasound has been developed as a valuable method in evaluation of endometrial preparation before embryo transfer in fresh IVF cycles (6).

This study aimed to assess the role of measurement of the endometrial thickness, morphology and sub-endometrial blood flows by 2D power Doppler ultrasound in prediction of pregnancy in IVF/ICSI cycles.

2. Patients and methods

This study is a prospective observational study including 100 women undergoing IVF/ICSI treatment at a University based IVF center. The ethical approval for the study was obtained from the institute's ethical committee. All the patients gave a written informed consent before enrollment in the study. The inclusion criteria of the study were as follow: (a) age between 20 and 39 years and (b) IVF/ICSI treatment due to many factors including tubal, male, PCOS or other unexplained factors. We excluded (a) patients under 20 years or above 39 years and (b) patients who were unable to give a written informed consent.

The down-regulation protocol and the dose of gonadotrophin used were determined by patient's age, ovarian reserve tests and prior response to ovarian stimulation as per unit protocol. Folliculometry was performed using transvaginal ultrasound scan starting from day six of stimulation and every other day afterwards till the day of hCG.

One expert radiologist evaluated each patient on day of hCG using 2D transvaginal ultrasound machine (Logiq P5, GE Medical Systems, Korea) with 7.5–9 MHz-convex array transducer as follows:

1. We use the gray scale function of the ultrasound machine to study and measure the endometrial thickness as the thickest part of the endometrium between the highly reflective echogenic lines in the true longitudinal scan of the uterus.
2. In this true longitudinal scan of the uterus, we note the endometrial pattern as either triple-line (described as hypoechoic endometrium surrounded by hyperechoic zones) or non-triple-line.
3. After then, we activate the Doppler function of the ultrasound machine to evaluate the endo-subendometrial blood flow or vascularization and is either, zone I in which the blood flow reached only subendometrial region, zone II in which the blood flow reached the outer hyper-echoic region or zone III in which the blood flow reached the inner hypo-echoic zone.
4. To evaluate the Doppler indices of the endometrial vasculature, we activate the pulsed power Doppler function of the machine and applied the Doppler gate over the appropriate color area then tried to have five or more consecutive waveforms for the study to be satisfactory (each wave represented maximum Doppler shift). Then we measure the resistive index = Peak systolic velocities – Peak diastolic velocities/Peak systolic velocities and standard of deviation ratio (S/D ratio) was calculated on three consecutive uniform waveforms.

Then we give 10,000 hCG IU intramuscular when there were minimum of three mature follicles measuring 17–18 mm in dimensions and after 36 h the ovum was picked up under intra-venous sedation. Two or three embryos were placed inside the uterine cavity of the patient on days 4–5 after the retrieval and good quality embryos were frozen. On the luteal phase we gave 800 microgram of micronized progesterone vaginally from day of embryo-transfer (ET) till 12 weeks of pregnancy. A serum pregnancy test was done two weeks after embryo transfer.

2.1. Study outcome

The primary outcome of the study was clinical pregnancy rate that defined as the presence of one or more gestational sac by ultrasound scan two weeks after a positive serum pregnancy test.

– The secondary outcome of the study was endometrial thickness and sub-endometrial blood flow.

2.2. Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Science (SPSS Inc, Chicago) version 21 for Microsoft Windows. Data were described in terms of mean ± SEM (standard error of the mean) for continuous variables and frequencies (number of cases) and percentages for categorical data. Independent Student's *t*-test was used to compare quantitative variables and Chi square test was used to compare categorical data. A P value $<0.05\%$ was considered significant. The receptor operating characteristic (ROC) curve analysis was performed to determine the best predictive values.

3. Results

The current study included 100 patients who underwent IVF/ICSI treatment. Pregnancy was achieved in forty patients. There was no difference in the demographic features, hormonal milieu, and ovarian response between pregnant and non-pregnant women as shown in Table 1.

There was no statistically significant difference in the Doppler indices of the sub-endometrial blood vessels between pregnant and non-pregnant women as shown in Table 2.