



ORIGINAL ARTICLE

# Three-dimensional power Doppler indices of ovarian stromal blood flow and serum vascular endothelial growth factor after laparoscopic ovarian drilling in women with polycystic ovary syndrome



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## KEYWORDS

PCOS;  
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**Abstract Objective:** To evaluate the effects of laparoscopic ovarian drilling (LOD) on three-dimensional (3D) power Doppler indices of ovarian stromal blood flow and serum vascular endothelial growth factor (VEGF) levels in women with polycystic ovary syndrome (PCOS).

*Design:* Prospective controlled study.

*Setting:* Minia University Hospital, Minia, Egypt.

*Material and methods:* 30 clomiphene citrate resistant women with PCOS undergoing LOD and 30 fertile women with normal ovaries were recruited in this study. Hormonal profile, Doppler indices of ovarian stromal blood flow and serum VEGF assays before and after LOD were evaluated and compared between the two groups. Evaluation was done at the beginning of the study, 1 week after LOD and at 3 and 6 month follow up periods.

*Main outcome measures:* 3-D power Doppler indices of both ovaries and serum VEGF concentration.

*Results:* Before LOD, serum levels of VEGF, total testosterone (T), free androgen index (FAI), LH, LH:FSH ratio, total antral follicle count (AFC), total ovarian volume (OV) and the 3D power Doppler blood flow indices were significantly higher in the PCOS group than in the control group. After LOD, there was a significant reduction in the serum levels of VEGF, T, sex-hormone binding

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globulin (SHBG), FAI, LH, LH:FSH ratio, AFC, OV and the 3D power Doppler indices and remained all low at 3 and 6 month follow up. There were significant positive correlations between power Doppler flow indices (VI, FI, and VFI) with serum VEGF, total T, and LH before and after LOD.

*Conclusions:* Serum VEGF and ovarian blood flow indices were higher in women with PCOS than in normal women. LOD reduced serum levels of VEGF, in addition to ovarian blood flow indices, in women with PCOS.

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## 1. Introduction

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder. It affects 5–10% of women of reproductive age and at least 75% of cases with anovulatory infertility. It is characterized by a marked increase in preantral follicle number arranged peripherally around a dense core of stroma or scattered throughout an increased amount of stroma. This is associated with menstrual disturbance, hyperandrogenism, and anovulation (1–4).

Laparoscopic ovarian drilling (LOD) is currently the method of choice to treat anovulatory women with PCOS resistant to clomiphene citrate (CC) (5). LOD causes minimal morbidity, precludes the need to monitor cycles, and has a low risk of multiple pregnancies. A reduction has been observed in the incidence of ovarian hyperstimulation syndrome (OHS) after LOD. This may be an advantage for women with PCOS who will receive gonadotropins for IVF (6).

Ovarian stromal blood flow can be assessed by both color Doppler and power Doppler ultrasound. The power Doppler technique is more sensitive (7). Ovarian stromal blood flow abnormalities in PCOS have been previously described (8,9). Ovarian stromal peak systolic blood flow velocity and time-averaged maximum velocity were found to be significantly greater in women with PCOS than in infertile women with healthy ovaries (10).

Vascular endothelial growth factor (VEGF) not only mediates angiogenesis but also induces connective tissue stromal growth by increasing microvascular permeability. Increased expression of VEGF has been described in the hyperthecotic stroma of polycystic ovaries; in addition, higher serum concentrations of VEGF have been found in women with PCOS than in normal women (11).

There are few studies addressing the effects of LOD on ovarian stromal blood flow using 3D power Doppler ultrasonography in women with PCOS (12–14). Evaluation of ovarian stromal blood flow before and after LOD may be considered a way to study the effects of this therapeutic intervention or the mechanism by which the ovary may respond (15). Therefore, this study was conducted to evaluate the effects of LOD on 3D power Doppler indices of ovarian stromal blood flow and VEGF levels in women with PCOS.

## 2. Patients and methods

This prospective controlled study was conducted in the department of Obstetrics and Gynecology, Minia University Hospital, Egypt during the period from January 2012 to April 2013 after being accepted by local research committee.

Thirty infertile patients with clomiphene-resistant PCOS and scheduled for LOD were recruited in this study. PCOS was diagnosed according to the 2003 ESHRE/ASRM (Rotterdam criteria) (4). Clomiphene resistance was defined as three consecutive cycles with CC 150 mg daily without ovulation (16). Thirty fertile women with regular menstrual cycle and normal ovaries (by ultrasound examination) were taken as the control group. Women selected for this study were fulfilling the following inclusion criteria: age between 19 and 35 years; primary anovulatory infertility for more than one year; BMI between 20 and 30 kg/m; normal hysterosalpingogram and their partners had normal semen analysis according to WHO criteria (17). Patients with other causes of infertility, organic pelvic diseases at laparoscopy or diseases potentially affecting the ovarian environment and/or function (e.g. endometriosis and leiomyomas), hyperprolactinemia, and those with chronic medical illnesses were excluded from the study. Thorough counseling was given and a written informed consent was obtained from each patient before recruitment in this study.

The recruited patients were subjected to history taking and clinical examination. Hormonal profile, Doppler indices of ovarian stromal blood flow and serum VEGF assays before and after LOD were evaluated and compared between the two groups. Evaluation was done at the beginning of the study, one week after LOD and at 3 and 6 month follow up periods.

All ultrasound examinations were performed using a 3D transvaginal 7.5-MHz power Doppler ultrasound machine (Voluson 530 D; Medison-kretz, Seoul-Zipf, Korea-Austria). All the quantitative measures were taken by experienced gynecologist. To determine the intra-observer error, thirty healthy controls were evaluated by the same operator in this study. During the examination, the Doppler settings were not changed. The region of interest included the whole ovarian region and excluded the supplying vessels. Both ovaries were accessible for evaluation (3–5 cm from the probe). After weighing the total color percentage and flow amplitude in the total volume of interest (18), the VOCAL (virtual organ computer aided analysis) software (Medison-Kretz) for the 3D power Doppler histogram analysis is used to analyze with computer algorithms to form indices of blood flow and vascularization. In brief, as reported by Pairleitner et al. (18), the vascularization index (VI) indicates the proportion of the volume showing a flow signal in the total volume of the ovary. It does not contain any information on the flow signal and intensity. The flow index (FI) is an average of the intensity of flow signal inside the ovary that carries no significance by itself. The vascularization flow index (VFI) is a combination of the information of vessel presence and amount of flow made by multiplying the FI and VI. During the analysis and calculation, the manual

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