Three-dimensional power Doppler study of endometrial and subendometrial microvascularization in women with intrauterine device–induced menorrhagia

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Objective: To evaluate endometrial and subendometrial microvascularization, using three-dimensional (3D) power Doppler ultrasound, in women with intrauterine device (IUD)-induced menorrhagia; and whether those potential findings could predict the risk of bleeding before IUD insertion.
Design: Prospective clinical trial.
Setting: University teaching hospital.
Patient(s): One hundred twenty women, who requested the insertion of a copper IUD for contraception.
Intervention(s): Endometrial thickness and volume, uterine artery pulsatility index and resistance index, and endometrial and subendometrial 3D power Doppler vascularization index, flow index, and vascularization flow index were measured twice: immediately before and 3 months after IUD insertion.
Main Outcome Measure(s): Doppler indices before and after IUD insertion.
Result(s): Before IUD insertion, no significant difference was detected in the clinical characteristics, endometrial thickness and volume, and Doppler indices between women who had IUD-induced menorrhagia (n = 47) and those without menorrhagia (n = 73). However, after IUD insertion, there was a significant increase in the endometrial and subendometrial vascularization index, flow index, and vascularization flow index in women with menorrhagia, whereas other parameters remained not significantly different between the two groups.
Conclusion(s): Endometrial and subendometrial microvascularization increases in women with IUD-induced menorrhagia; however, this finding has no predictive value before IUD insertion. (Fertil Steril® 2013;99:1912–5. ©2013 by American Society for Reproductive Medicine.)
Key Words: 3D power Doppler, endometrial and subendometrial vascularity, intrauterine device, menorrhagia

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The copper intrauterine contraceptive device (IUD) is the most commonly used method of long-acting reversible contraception worldwide (1). The most important copper IUD-related side effect is increased menstrual bleeding, often combined with cramping. These changes are responsible for a removal rate of 4%–15% during the first year after IUD insertion (2).

The effect of the copper IUD on uterine hemodynamics and its relationship with the pathophysiology of IUD-induced menorrhagia are still not well clarified. By using two-dimensional (2D) power Doppler analysis, only a few studies have demonstrated an increase in subendometrial vascularization in women with IUD-induced menorrhagia (3, 4).

Using power Doppler in combination with three-dimensional (3D) ultrasound provides the possibility of quantifying vascularization within a given volume of interest (5). This technique could be a unique noninvasive tool for the

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evaluation of reproductive processes; to examine the blood supply toward the endometrium and the subendometrial region (6).

The aim of this study was to evaluate endometrial and subendometrial microvascularization, using 3D power Doppler ultrasound, in women with IUD-induced menorrhagia; and whether those potential findings could predict the risk of bleeding before IUD insertion.

MATERIALS AND METHODS

This prospective clinical trial was conducted at the Department of Obstetrics and Gynecology, Kasr El-Ainy Teaching Hospital, Faculty of Medicine, Cairo University, during the period from March 2011 to October 2012. The study population consisted of 120 consecutive women who requested the insertion of a copper IUD for contraception. The study protocol was reviewed and approved by the Scientific Research Committee, and informed consent was obtained from all participants.

The inclusion criteria were age from 30 to 40 years, parity from 1 to 3, regular menstrual cycle (varying from 25 to 35 days), and body mass index (BMI) <30 kg/m^2. The exclusion criteria were menorrhagia, pregnancy, congenital uterine anomalies, acute or chronic pelvic inflammatory disease, cervicitis, benign or malignant gynecologic tumors, and history of oral contraceptives, hormonal medications, or IUD usage within 3 months before the study. The women were also instructed not to use nonsteroidal anti-inflammatory drugs within 24 hours before any ultrasound examination (7).

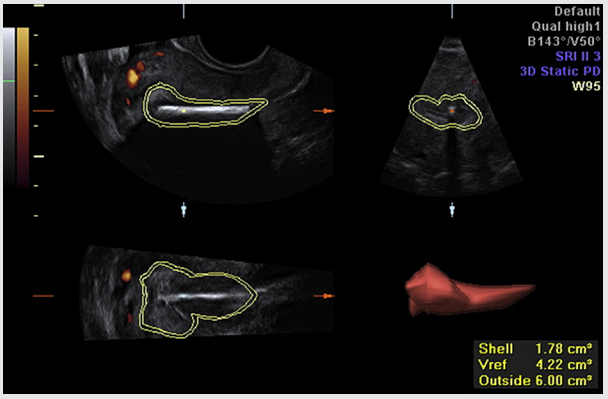
The copper IUD (TCu 380A; Pregna-DKT) was inserted postmenstrual between days 7 and 10 of the cycle. Transvaginal ultrasound (Voluson 730; Kretz Technic) examinations were performed twice: immediately before IUD insertion and 3 months later. Both ultrasound examinations were carried out between days 7 and 10 of the cycle to exclude a possible effect of menstrual cycle phase (8); and between 9:00 and 10:00 AM to avoid circadian rhythm variation (9).

The endometrial thickness was measured as the thickest part in the sagittal plane (double layer, excluding the vertical arm of the IUD). Then, color Doppler was activated in the 2D mode. The flow velocity waveforms were obtained from the ascending main branch of the uterine artery on both sides of the internal os. Three similar consecutive waveforms of good quality were analyzed. The right and left uterine artery pulsatility index (PI) and resistance index (RI) were calculated, and the averaged PI and RI were given.

The ultrasound machine was switched to the 3D mode with power Doppler. The setting conditions for this study were standardized using a frequency at 3–9 MHz, pulse repetition frequency at 0.6 kHz, gain at −4.0, and wall motion filter at low 1. The Virtual Organ Computer-Aided Analysis Imaging Program, with the application of "shell-imaging" if indicated (Fig. 1), was used to measure the endometrial volume and 3D power Doppler indices within the endometrium (excluding the IUD) and the subendometrial region (1 mm parallel to the originally defined myometrial–endometrial contour) (10).

Vascularization index (VI) measures the ratio of the number of color voxels to the total number of voxels (%) and represents the presence of blood vessels (vascularity). Flow index (FI) measures the mean power Doppler signal intensity (0–100) and represents the average intensity of blood flow. Vascularization flow index (VFI) is calculated by multiplying VI and FI (0–100) and represents a combination of vascularity and flow intensity (5).

FIGURE 1



Virtual Organ Computer-Aided Analysis with shell-imaging of the subendometrial region.

El-Mazny. IUD and 3D power Doppler. Fertil Steril 2013.

The women were continually allocated into two groups according to the changes in menstrual bleeding pattern 3 months after IUD insertion. Group A corresponded to women with IUD-induced menorrhagia (subjective increase in the amount and/or duration of the menstrual bleeding). Group B included those who did not present menorrhagia.

Statistical Analysis

Data were expressed as mean ± SD (95% confidence interval [CI]). The Student *t* test was used to compare the relevant variables in the two groups before and after IUD insertion. A two-tailed *P* value $<.05$ was considered statistically significant. The Statistical Package for the Social Science (SPSS), version 16.0, was used for data analyses.

RESULTS

A total of 120 women completed the study protocol; 47 (39.2%) had menorrhagia after IUD insertion (group A), whereas 73 (60.8%) had no menorrhagia (group B). There was no significant difference in the clinical characteristics, age ($P=.273$), parity ($P=.387$), duration of menstrual cycle ($P=.851$), and BMI ($P=.248$), between the two groups (Table 1).

Before IUD insertion, no significant difference was detected in the endometrial thickness ($P=.102$), uterine artery PI ($P=.158$) and RI ($P=.118$), endometrial volume ($P=.184$), endometrial VI ($P=.512$), FI ($P=.132$) and VFI ($P=.398$), and subendometrial VI ($P=.127$), FI ($P=.159$), and VFI ($P=.677$) between the two groups (Table 1).

After IUD insertion there was a significant increase in the endometrial VI ($P=.015$), FI ($P=.021$), and VFI ($P=.001$) and subendometrial VI ($P=.035$), FI ($P=.027$), and VFI ($P=.003$) in group A compared with group B, whereas the endometrial thickness ($P=.219$), uterine artery PI ($P=.699$) and RI ($P=.788$), and endometrial volume ($P=.303$) remained not significantly different between the two groups (Table 2).