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Ovarian parameters and ovarian blood flow of women living in the area of environmental crisis

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ABSTRACT

Background and objectives: Exposure to environmental hazards will destroy a number of ovarian primordial follicles, reduce ovarian reserve and subsequent reproductive ability. This study designed to evaluate ovarian parameters and ovarian blood flow of women living in the area of environmental crisis Shalkar city (Kazakhstan) compared to women living in Aktobe city (Kazakhstan).
Patients and methods: 220 women in their reproductive age studied and classified into two groups; study (Shalkar) group and control (Aktobe) group. Blood sample taken from studied women during follicular phase (day 3) for hormonal level evaluation including; follicle stimulating hormone (FSH) and anti-Mullerian hormone (AMH). Studied women evaluated using trans-vaginal ultrasound (TVS) to detect antral follicle count (AFC) during follicular scan and ovarian volume (OV), ovarian blood flow (OBF) using pulsatility index (PI) during follicular scan and luteal scan.
Results: Both ovaries AFC was significantly less in study (Shalkar) group compared to and control (Aktobe) group ($p = 0.0001$). Mean ovarian volume was significantly less in Shalkar group in both follicular phase and luteal phase (5.86 ± 0.23 and 6.19 ± 0.22 Cm^3; respectively) compared to Aktobe group (6.85 ± 0.19 and 6.92 ± 0.18 Cm^3; respectively). In addition, mean ovarian pulsatility index was significantly high with subsequent decrease in ovarian blood flow in Shalkar group in both follicular phase and luteal phase (3.36 ± 0.20 and 3.45 ± 0.19 Cm/s; respectively) compared to Aktobe group (2.96 ± 0.16 and 2.92 ± 0.15 Cm/s; respectively).
Conclusion: This study suggests definite environmental effect on ovarian parameters as indicated by decreased AFC, decreased both follicular and luteal OV and OBF in women living in environmental crisis Shalkar group compared to Aktobe group.

Introduction

Women reproductive function depends on the functional capacity of the ovaries [1–3]. Pathological conditions arise after violation of the ovarian function and its blood supply [4,5].

The ovary is a well-vascularized organ. Angiogenesis is an essential factor for the growth and regression of the ovarian follicles and corpus luteum [6]. Therefore, the investigation of vascular changes in the ovaries, follicles and corpus luteum may yield important information on normal and pathologic ovarian conditions [7,8]. Ultrasound and Doppler facilities the morphological and vascular assessment of the ovaries [9,10]. Doppler studies can detect vascular ovarian changes in the ovaries during the normal menstrual cycle and in the corpus luteum in early pregnancy [11,12].

The introduction of non-invasive trans-vaginal color technique has made it possible to study uterine and ovarian perfusion directly [13].

Color Doppler technology used to detect the blood flow directed to the uterus and ovary in relation to cyclic hormonal changes. For example, increased blood flow characterizes the pre-ovulatory follicle in spontaneous cycles, with a peak in blood flow velocity occurring during the day of ovulation [14].

Vascularization of the reproductive organs also undergoes remarkable modifications in many pathological conditions. Blood

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flow study of vascular resistance of the stromal vessels seems to predict the risk of severe ovarian hyper-stimulation syndrome in in vitro fertilization stimulated women and anovulation [13,14].

The Doppler Resistance index (RI) examines the difference between the peak systolic and end diastolic velocities and suitable for low resistance vascular beds with continuous flow throughout diastole [14].

While the Doppler mean pulsatility index (PI) often used for vessels where flow is absent during all or part of diastole [14,15].

One of these environmental problems is the disaster of Central Asia the Aral Sea tragedy, which had begun in the 60s and has long-term consequences until now [16].

The uncontrolled use of water resources for purpose of irrigation, use of toxicants, led to the drying of the Aral Sea [17]. Dust and sandstorms have become carriers of fertilizers, pesticides, herbicides and other substances from the bottom of the Aral Sea which can freely distributed by the winds beyond the epicenter [18,19].

This study designed to compare ovarian parameters including; FSH, AMH, AFC, OV, OBF of women living in the area of environmental crisis Shalkar city to women living in Aktobe city as control group without environmental crisis.

Patients and methods

This comparative study conducted over 2 years from 2012 to 2014 in West Kazakhstan Marat Ospanov state Medical University (ZKGMU) after approval of study by local institute ethical committee.

Two hundred and twenty (220) women in their reproductive age (27–40 years old) included in this comparative study and classified into two groups; study (Shalkar) group and control (Aktobe) group.

The purpose of the study and the procedures explained to all studied women and a written informed consent obtained from each woman.

Thorough evaluation of studied women including; age, duration of marriage, number of pregnancies and miscarriages, age of menarche, menstrual history, body mass index (BMI), documentation of ovulation by transvaginal ultrasound (TVS) and normal uterine cavity.

Women with following criteria included in this study; (I) 27–40 years' age (II) regular ovulatory menstrual cycles every 25–35 days; (III) both ovaries present; (IV) no current or past diseases affecting ovaries or sex steroid secretion, clearance or excretion; (V) BMI < 25 kg/m^2; (VI) no current hormone therapy and (VII) adequate visualization of ovaries at TVS.

Women with polycystic ovary syndrome (PCOS), endocrine or medical disorders, endometriosis, previous pelvic surgery, genital malformations, BMI > 25 kg/m^2, hormonal intake within last 6 months excluded from this study. Blood sample taken from studied women during follicular phase for hormonal level evaluation including day 3 follicle stimulating hormone (FSH) and anti-Mullerian hormone (AMH) [20].

Studied women evaluated using TVS to detect antral follicle count (AFC) during follicular scan (3–5th day of menstrual cycle) and ovarian volume (OV), ovarian blood flow (OBF) using PI during follicular scan and luteal scan (11–14th day of menstrual cycle) [21–23].

AFC is the number of follicles visualized in both ovaries with size from 2 to 10 mm in early follicular phase by TVS.

To determine diameter of each antral follicle, the mean of measurements in two perpendicular directions taken.

Baseline measures included transverse (T), anteroposterior (AP), and longitudinal (L) diameters of both ovaries and ovarian volume (V), was estimated using the formula V (cm) = T (Cm) × AP (Cm) × L (Cm) × 0.52.

Left and right ovarian artery flow in the pelvic infundibulum visualized with the color Doppler technique and the typical velocity spectrum of this vessel was determined. Blood flow impedance was expressed as the Pulsatility Index (PI) which was calculated by the ultrasound machine built in software.

TVS and color Doppler done using Accuvix V10 ultrasound machine (Samsung Medison Bldg, Teheran, Korea) with trans-vaginal 2D convex probe 4–9 MHz, by a sonographer who blinded to patients' criteria.

Collected data at the end of the study statistically analyzed to compare ovarian parameters including; FSH, AMH, AFC, OV and OBF using PI of women living in the area of environmental crisis Shalkar city to women living in Aktobe city (control group).

Sample size and statistical analysis

Required sample size was calculated using G* Power software version 3.17 for sample size calculation (Heinrich Heine Universität; Düsseldorf; Germany), setting α-error probability at 0.05, power (1-β-error probability) at 0.95% and effective sample size (w) at 0.3. The effective size (w) was calculated as follows: $w - \sqrt{X^2/N}$, where X^2 is the chi-square test and N is the total sample size. Number of participants needed to produce a statistically acceptable figure was 110 women in each group.

Statistical analysis performed using statistical package for social sciences (SPSS) for Windows version 18 (Chicago, IL, USA). Numerical variables presented as mean and standard deviation (±SD) and Student t-test used for comparison between two studied groups as regard quantitative values. A difference with a p-value <0.05 was considered statistically significant.

Results

There was no significant difference between two studied groups; mean age, BMI, parity, miscarriages and length of menstrual cycle. In addition, there was no significant difference between two studied groups regarding day-3 mean FSH and AMH, while, both ovaries AFC was significantly less in study (Shalkar) group compared to and control (Aktobe) group (p = 0.0001) (Table 1).

Table 1
Characteristics, AFC, FSH and AMH of the studied groups.

Variables	Study (Shalkar) group (110 women) Mean ± SD	Control (Aktobe) group (110 women) Mean ± SD	p-Value (95% confidence interval of difference)
Age (years)	31.3 ± 2.64	29.9 ± 3.92	0.9* (0.5, 1.4, 2.3)
Body mass index (BMI) (kg/m^2)	24.3 ± 3.11	23.8 ± 4.5	0.9* (−0.6, 0.4, 1.4)
Parity	2.3 ± 0.8	1.8 ± 0.9	0.9* (0.3, 0.5, 0.7)
Miscarriages	1.2 ± 0.43	0.8 ± 0.66	0.9* (0.3, 0.4, 0.6)
Length of menstrual cycle	27.6 ± 1.4	28.3 ± 2.6	1* (−1.3, −0.7, −0.2)
Both ovaries AFC	10.2 ± 9.7	26.5 ± 6.8	0.0001** (−18.5, −16.3, −14.1)
FSH (mIU/ml)	8.5 ± 9.7	6.7 ± 5.2	0* (−0.3, 1.8, 3.8)
AMH (ng/ml)	4.3 ± 2.1	2.5 ± 0.6	0* (1.4, 1.8, 2.2)

AFC, antral follicle count; AMH, anti-Mullerian hormone; FSH, follicle stimulating hormone; Student t-test used for statistical analysis.
* Non-significant difference.
** Significant difference.