Journal of Assisted Reproduction and Genetics, Vol. 19, No. 1, January 2002 (© 2002)

SHORT COMMUNICATION

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A Prospective Novel Method of Determining Ovarian Size During In Vitro Fertilization Cycles[1]

Submitted July 23, 2001; accepted August 23, 2001

***Purpose*:** Recently ovarian volume has been touted as a means to evaluate ovarian reserve in assisted reproductive technology cycles. In this study, a novel method of determining ovarian size was evaluated and compared to the standard three-dimensional ovarian volume measurement during in vitro fertilization (IVF).

***Methods*:** This prospective observational study consisted of 60 consecutive patients undergoing baseline transvaginal ultrasonography for IVF from July to August, 1999. The main outcome measures were mean ovarian size and mean ovarian volume.

***Results*:** The patients' ages ranged from 23 to 43 years with a mean age of 33.86 ± 4.5 years. The mean ovarian size was 2.19 ± 0.4 cm (range 1.40–3.40). The mean ovarian volume was 5.02 ± 2.7 cm^3 (range 1.71–16.5 cm^3). By linear regression there was a 90% correlation between the two methods of ovarian measurement ($r = 0.90$, $p < 0.01$).

***Conclusions*:** These results demonstrated a strong correlation between these two methods of determining ovarian size. Mean ovarian diameter measured in the largest sagittal plane is a good estimation of ovarian volume and may be used to quickly assess ovarian status prior to undergoing IVF.

KEY WORDS: In vitro fertilization; ovarian reserve; ovarian size; ovarian volume; transvaginal ultrasound.

[1] The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

INTRODUCTION

There are few noninvasive outcome predictors available to patients and clinicians before starting an ART cycle. Such predictors are helpful for counseling couples regarding the potential success expected when pursuing these expensive treatments. Likewise, accurate methods of predicting success allow for appropriate stimulation protocol selection. Advanced maternal age is associated with diminished ovarian responsiveness and decreased clinical pregnancy rates and live birth rates in women pursuing ART (1). An elevated cycle Day 3 FSH level reflects reduced ovarian reserve, reduced ovarian responsiveness to stimulation, and reduced pregnancy rates (2). It has been the clinical impression of some that women with small ovarian size on ultrasound responded poorly to subsequent controlled ovarian stimulation (3,4).

Measurement of ovarian volume by transvaginal ultrasonography is accurate and easily performed in most women. Interobserver variation in transvaginal ultrasound volume measurements has been shown to be very low (5). These characteristics enhance the value of this relatively noninvasive test.

We have shown in a previous study that a mean ovarian diameter of less than 20 mm was associated with an increased risk of cycle cancellation (6). Likewise, we demonstrated that mean ovarian diameter correlated well with ovarian reserve screening and stimulation parameters. We propose using a simplified two-dimensional formula to evaluate ovarian size ($V = (D_1 + D_2)/2$). This is a common method used to measure and evaluate ovarian follicle size during an in vitro fertilization (IVF) cycle. If this simplified two-dimensional formula significantly correlates with the three-dimensional ovarian volume evaluation, reproductive endocrinologists will be able to assess ovarian size efficiently prior to starting an IVF stimulation and possibly alter their stimulation protocols based on findings.

MATERIALS AND METHODS

We prospectively recruited 60 consecutive patients undergoing IVF from July to August, 1999, meeting our inclusion criteria. All patients enrolled in the study had both ovaries intact, no history of ovarian surgery, absence of ovarian pathology, and both ovaries were visible on transvaginal ultrasonography. All patients had a Day 3 FSH in the normal range (<12 mIU/mL) for our program. Patients meeting

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these criteria were included regardless of infertility diagnosis or age. After oral contraceptive or GnRH-a ovarian suppression, transvaginal ultrasonography was performed at the patient's baseline appointment 3 days prior to starting gonadotropins. All data were prospectively charted. Institutional review board approval was obtained, and all patients consented prior to being enrolled in the study.

The primary response variables were mean ovarian size and mean ovarian volume. Mean ovarian size was calculated using two diameters in the largest sagittal plane of the ovary. The formula $((D_1 + D_2)/2)$ was used to calculate mean ovarian size. For volume calculations, these two diameters were used in conjunction with the largest diameter in the coronal plane of the ovary. Ovarian volume was calculated using the prolate ellipsoid formula, $V = D_1 \times D_2 \times D_3 \times 0.523$. A mean ovarian size and mean ovarian volume were then calculated for each patient. The correlation between the two transvaginal ovarian measuring methods was then assessed.

It was assumed that the correlation between the two-dimensional and three-dimensional measurements would be greater than $r = 0.80$. A sample size of 60 patients was deemed appropriate. With a sample of 60 subjects, the 95% confidence interval for a correlation of 0.90 was 0.84–0.94 or about ± 0.05. The 95% confidence interval for a correlation of 0.80 was 0.69–0.88 or about ± 0.10.

RESULTS

The patients had a mean of 2.8 ± 2.2 years of infertility. The patients' ages ranged from 23 to 43 years with a mean age of 33.86 ± 4.5 years. The mean Day 3 FSH was 5.9 ± 2.4 mIU/mL (range 0.6–11.3 mIU/mL). The mean Day 3 LH was 5.3 ± 3.1 mIU/mL (range 0.1–17.9 mIU/mL). The mean Day 3 Estradiol was 22.3 ± 9.4 pg/mL (range 10.0–80.6 pg/mL).

The mean ovarian size was 2.19 ± 0.4 cm (range 1.40–3.40). The mean ovarian volume was 5.02 ± 2.7 cm^3 (range 1.71–16.5 cm^3). By linear regression there was a 90% correlation between the two methods of ovarian measures ($r = 0.90$, $p < 0.01$) (Fig. 1).

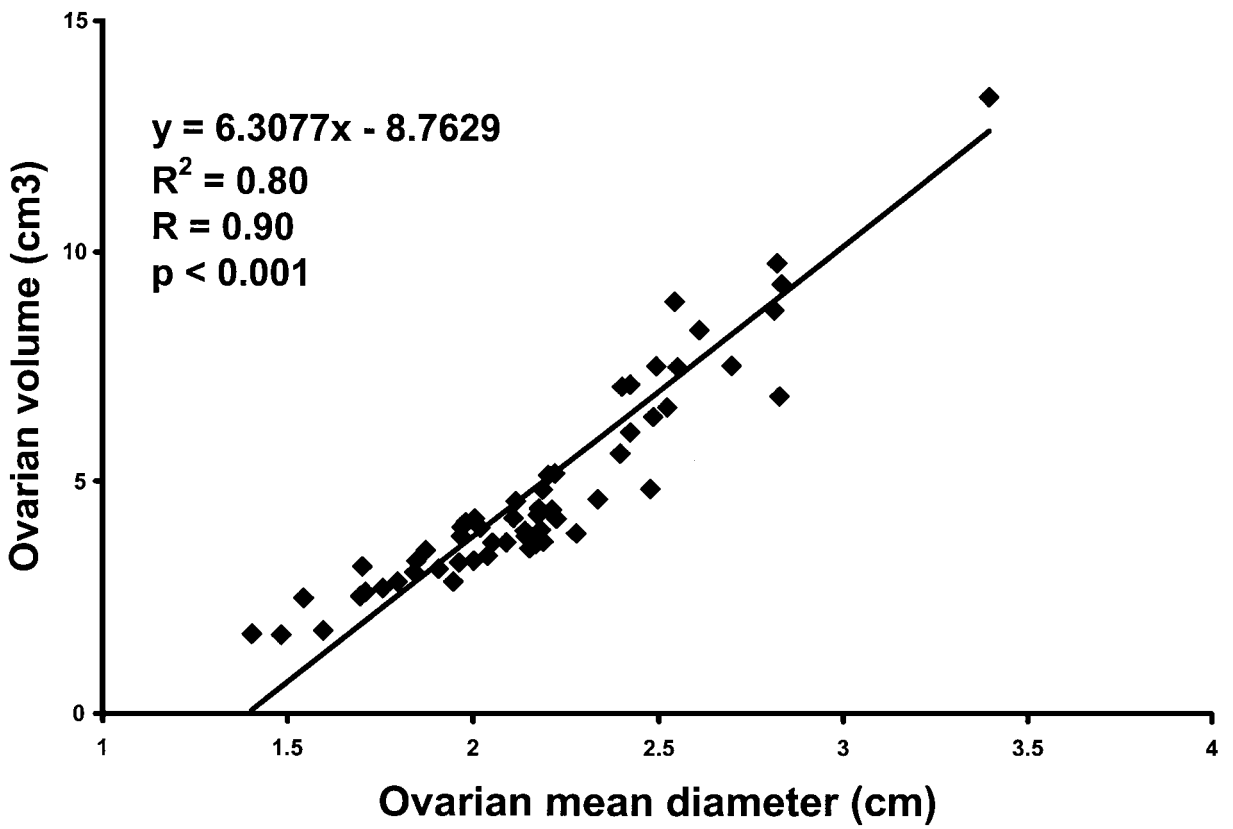

Fig. 1. Linear regression demonstrating a 90% significant correlation between mean ovarian diameter and ovarian volume.

There was no significant difference between the mean right ovarian size (2.18 ± 0.5 cm) and left ovarian size (2.19 ± 0.4 cm). Likewise, the right and left ovarian volume measurements were similar at 5.08 ± 2.9 and 4.97 ± 3.8 cm^3 respectively.

The total antral follicle count per patient was 15.0 ± 9.6. On average the right ovary demonstrated more antral follicles (8.2 ± 5.2 vs. 7.0 ± 4.9) than did the left ovary. Using the Mann-Whitney Rank Sum Test, this difference approached but did not reach statistical significance ($p = 0.09$).

DISCUSSION

This prospective observational study confirms that mean ovarian diameter significantly correlates with mean ovarian volume. As we previously published in a retrospective analysis, mean ovarian diameter significantly correlated with age, Day 3 FSH, Day 3 LH, and Day 3 Estradiol (6). Likewise, our previous study demonstrated that mean ovarian diameter significantly correlated with the ovarian stimulation parameters of ampules of gonadotropins used, days of stimulation, and peak estradiol level.

Transvaginal ultrasonography is an accurate tool for measuring ovarian volume. Each ovary is measured in three planes, and ovarian volume is calculated. The three planes being measured are the longitudinal, antero-posterior, and transverse diameters respectively. A mean ovarian volume is then calculated for each patient. However, this calculation is a time-consuming and mathematically complex method of determining ovarian volume. Therefore, few physicians use ovarian volume measurement to assess their patients prior to IVF.

Our results demonstrated a strong correlation between these two methods of determining ovarian size. Although a strong association between ovarian volume and ovarian reserve has been observed, few physicians use this method of evaluating ovarian reserve prior to IVF. The additional time involved in obtaining the ovarian volume measurements and then calculating the ovarian volume often dissuades providers from obtaining ovarian volume assessment. By using a simplified method to determine ovarian size, the physician can more effectively assess ovarian reserve during baseline ultrasound examination and thus change the patient's stimulation protocol to optimize results. We await the results of a larger ongoing prospective study evaluating ovarian stimulation parameters and clinical outcomes in relation to mean ovarian diameter.

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