Ultrasonic Measurement of Female Pelvic Reproductive Organs and Comparison of Body Mass Index (BMI) Between Fertile and Infertile Women

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Abstract

Background: To determine the ultrasonic measurement of female pelvic reproductive organs and compare the BMI between fertile and infertile women.

Methods: In this descriptive study 120 women, 60 fertile and 60 infertile, subdivided into age groups 20 to 30, and 31 to 40, were included. Total ovarian volume (OV) was determined transabdominally (OV-TA) and transvaginally (OV-TV), antral follicle count (AFC), uterine size (US) and endometrial thickness (ENDO) performed transvaginally, and BMI calculated.

Result: The ovarian reserve, uterine size, and BMI were strong indicators of fertility of a woman. Ovarian volume, uterine size, and endometrial thickness were significantly increased in the younger fertile group as compared to the infertile group. Comparison of these variables showed a different pattern in the older fertile and infertile women. In the older fertile only the US was significantly larger than the infertile older group.

Conclusion: Early measurement of these female pelvic reproductive organs can prevent primary infertility if the female is properly counseled regarding outcome of delaying conception.

Key Words: Ovarian Reserve, Ovarian volume, Antral follicle count, Endometrial thickness, BMI

Introduction

Delaying voluntarily to have a child contributes to infertility. Women show maximum fertility before the age of 30-31. From this age onwards there is a decrease in the fertility capability of a woman which accelerates towards decline in fertility around the age of 40 years. From this age onwards reproductive aging is related to decrease in ovarian volume and to decrease in quantity and quality of the antral follicles. The ovarian volume and the number of antral follicles are an indication of ovarian reserve. The ovarian reserve is a good reliable indicator of fertility which decreases with age; however some women may be born with a lesser ovarian reserve which may be depleted soon.

Therefore, ovarian reserve may be checked by a non-invasive method, like ultrasound, the result of which can reduce the chances of sub or infertility. The variable used for detecting ovarian reserve by ultrasonography is the calculation of OV and AFC during the early phase of the menstrual cycle which is from 2nd to 7th day. These variables can be easily determined by transabdominal (TAS) and transvaginal (TVS) ultrasound scanning techniques. Endometrial thickness can also be used as an important indicator for fertility. The endometrial thickness can be compared to ovarian volume and they have shown to have a direct correlation. A significant relation is seen with a decrease in fertility which shows a decrease in ovarian reserve and the presence of a thin endometrium.

An increase in the height of the uterus, its fundal cervical ratio and ovarian volume for girls between the ages of 8-15 years has been shown. A strong relationship is present between body mass index and ovarian volume. Studies have shown that that the relationship between the two parameters is a negative one. This is significant as overweight and obesity are strongly linked with a reduction in fertility. Low endometrial volume is a strong predictor of early pregnancy loss in women who are undergoing in vitro fertilization. Women who have shown to have an endometrial volume of <2ml are subfertile or maybe infertile. Hypertension, diabetes mellitus, parity, hormones, contraceptives, increasing age, and smoking are also shown to be associated with endometrial volume and uterine size. The importance of assessing these female reproductive organs by ultrasonic measurements and their comparison with BMI may help in determining early ageing of the organs.

Subjects and Methods

This ultrasound based study was conducted on fertile and infertile women (n=120) who were between
the ages of 20-40 years. The ovaries, antral follicles, uterine size and endometrium were observed and measured by transabdominal and transvaginal ultrasound scan. The study was conducted between December 2009 and June 2010 in the outpatient department of Rahat Hospital Karsaz, Karachi.

Fertile women with at least one normal pregnancy within the last one year and who had not used any contraceptive measures for the last 2 months were inducted for the study. The inclusion criteria for the infertile women were primary infertility for at least one year after having unprotected intercourse with a fertile male partner. Women suffering from any malignant disease, hypertension, diabetes mellitus, abnormal ovaries (eg polycystic ovary), surgical intervention of any pelvic reproductive organs and those on hormonal treatment, were excluded. There were 60 fertile and 60 infertile women divided into two groups each of ages that is 20-30 and 31-40 years. Ultrasound scan was done from 2nd to 7th day of their menstrual cycle. The transabdominal scan was performed on a full urinary bladder and transvaginal on an empty urinary bladder. Both ovaries were scanned by TAS and TVS separately in the longitudinal (D1), anteroposterior (D2) and transverse diameter (D3). Total ovarian volume was calculated by applying volume of an ellipsoid equation which is $D1 \times D2 \times D3 \times 0.523 \text{ cm}^3$ and the sum of the two ovaries was noted. For the antral follicle count, the follicles considered were between 0.2-1 cm in each ovary. These were counted and the sum of antral follicles was taken as the final count. This was observed by TVS only.

The uterus was measured from the top of the fundus to the cervix which was considered as the uterine length and the anteroposterior (AP) diameter was noted by TVS only. The uterine size (uterine length $\times$ uterine AP) was calculated in cm. The endometrial thickness was measured in cm by TVS.

BMI was calculated by taking the height and weight of each subject recruited and applying the formula Kg/m$^2$. The readings were taken twice for all variables and their average considered the final reading. p-value of 0.05 or less was considered statistically significant.

**Results**

A significant difference was present in the OV. The AFC however showed no statistical difference. The uterine size was larger in the fertile women as compared to the infertile women. The endometrium was significantly thicker in fertile women. The comparison between fertile and infertile women showed no significant difference between OV and AFC. There was no difference in BMI between fertile and infertile women. The only significant difference was in the uterine size (Table 1 & 2).

**Table 1: Comparison of variables between fertile and infertile young women**

<table>
<thead>
<tr>
<th>Age 20-30</th>
<th>Fertile</th>
<th>Infertile</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control-1</td>
<td>Case-1</td>
<td></td>
</tr>
<tr>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=30)</td>
<td>(n=30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OV(TAS)</td>
<td>14.35 ± 3.67</td>
<td>7.33 ± 3.17</td>
<td>0.001*</td>
</tr>
<tr>
<td>OV(TVS)</td>
<td>16.69 ± 4.11</td>
<td>8.79 ± 2.19</td>
<td>0.001*</td>
</tr>
<tr>
<td>AFC</td>
<td>8.92 ± 1.71</td>
<td>8.41 ± 2.18</td>
<td>0.492</td>
</tr>
<tr>
<td>BMI</td>
<td>22.5 ± 3.9</td>
<td>25.6 ± 4.7</td>
<td>0.066</td>
</tr>
<tr>
<td>US</td>
<td>144.8 ± 45.5</td>
<td>86.9 ± 25.7</td>
<td>0.001*</td>
</tr>
<tr>
<td>ENDO</td>
<td>0.60 ± 0.17</td>
<td>0.45 ± 0.14</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

**Table 2: Comparison of variables between fertile and infertile older women**

<table>
<thead>
<tr>
<th>Age 31-40</th>
<th>Fertile</th>
<th>Infertile</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control-2</td>
<td>Case-2</td>
<td></td>
</tr>
<tr>
<td>Mean ± S.D</td>
<td>Mean ± S.D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=30)</td>
<td>(n=30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OV(TAS)</td>
<td>7.92 ± 2.0</td>
<td>6.87 ± 2.49</td>
<td>0.203</td>
</tr>
<tr>
<td>OV(TVS)</td>
<td>9.97 ± 2.99</td>
<td>8.44 ± 2.36</td>
<td>0.143</td>
</tr>
<tr>
<td>AFC</td>
<td>5.30 ± 2.05</td>
<td>3.75 ± 2.80</td>
<td>0.082</td>
</tr>
<tr>
<td>BMI</td>
<td>24.4 ± 3.8</td>
<td>27.6 ± 5.7</td>
<td>0.069</td>
</tr>
<tr>
<td>US</td>
<td>188.8 ± 70.0</td>
<td>117.2 ± 29.0</td>
<td>0.002*</td>
</tr>
<tr>
<td>ENDO</td>
<td>0.66 ± 0.21</td>
<td>0.58 ± 0.19</td>
<td>0.349</td>
</tr>
</tbody>
</table>

Note: OV (TAS) = ovarian volume in cm$^3$ (transabdominal scan), OV (TVS)= ovarian volume (transvaginal scan); AFC= antral follicle count; BMI= body mass index; US=uterine size in cm, ENDO=endometrial thickness in cm

**Discussion**

Studies reveal that a reduction of OV is the reason for reduced fertility. Reduction of antral follicles is also reported in the infertile women but present study differs in this aspect in both the younger and older groups. The uterine size and endometrial thickness is also affected by fertility showing that in majority of the cases the uterine length is shorter in infertile women and this effect is significantly evident in women suffering from polycystic ovaries.14,15

A decrease in the endometrial volume may be a predictor of early pregnancy loss in subfertile women who are undergoing in-vitro-fertilization (IVF). It was seen that pregnancy loss was more in number with endometrial volume or thickness of <2ml as compared to those with thickness ≥2ml. We found endometrial thickness greater in fertile women during the
menstrual phase between the 2nd and the 7th day of the cycle. There are several other factors which are known to be associated with uterine size and endometrial thickness. This includes use of hormonal replacement therapy, presence of fibroids and uterine cancers e.g leiomyomas. Other factors may include smoking, parity, hypertension and diabetes mellitus.\textsuperscript{16,17}

In spite of other non-invasive techniques, ultrasound proves to be the most convenient technique to rule out female pelvic anomalies. It has also been stated that women with an endometrial lining of <6mm will rarely conceive although in our study the endometrial thickness noted was 0.60 cm +/- 0.17 and 0.66cm +/- 0.21 in the young and older fertile women respectively.

BMI has shown a significant correlation with uterine size and ovarian volume. The uterine weight has shown an increase of 7.56 g for every point of increase in BMI. Present study did not find any significant difference between BMI of fertile and infertile women. Studies coorelate an increase is BMI with a decrease in fertility. It has also been observed that incidence of miscarriages is increased if the woman is obese; it also lowers the success rate of assisted reproduction technique (ART) cycles.\textsuperscript{18}

Women with appropriate ovarian reserve, uterine volume, endometrial volume and BMI can incur, to some extent, the risk of delay in conception. If these reproductive organs are of lower volume and size it can be associated with primary infertility.

Conclusions

1. Early evaluation of the status of female pelvic reproductive organs can reduce the chances of primary infertility.
2. Ultrasound measurement of female pelvic reproductive organs can enable to predict the outcome of conception with increasing age and before delaying pregnancy.

References