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Measuring ovarian volume during cesarean delivery provides valuable information about future ovarian function and reproductive capacity

Sezaryen doğum esnasında yumurtalık hacminin ölçülmesi gelecek daha sonraki yumurtalık işlevi ve gebelik potansiyeli hakkında değerli bilgi sağlayabilir

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SUMMARY

Objective: Ovarian volume has a potential to be used in the indirect estimation of human ovarian reserve. The aim of this study was to determine ovarian volume measured during cesarean delivery at term pregnancy and to correlate the ovarian volume with maternal age and obstetric parameters.
Method: Ovarian exploration was performed in women undergoing cesarean delivery. Each ovary was measured in three dimensions (height, width, and depth), and right and left ovarian volumes were determined using a simplified formula for a prolate ellipse.
Results: Totally, 132 patients were found to be eligible for the study. Two-way ANOVA test (factors: Age groups and ovarian side) revealed significantly higher right ovarian volumes overall ($p<0.05$). However, we did not observe any significant interaction between side of the ovaries and the age groups ($p>0.05$). We also observed significant strong correlation between right and left ovarian volumes ($r=0.69$; $p<0.05$). There was no significant correlation between the right or left ovarian volumes and obstetric parameters ($p>0.05$). When we evaluated the left or right side separately, we found no significant difference in volumes among age groups ($p>0.05$).
Conclusions: Cesarean delivery as an operation performed during reproductive period can be an opportunity to evaluate and to record the right and left ovarian volumes directly and correctly. Our findings support that during the time of delivery, the right ovarian volume is higher than left one. The information about the ovarian volumes may provide important information to solve future reproductive problems. In women with small sized ovaries, information about her ovarian reserve can be given before her discharge.
Keywords: Ovarian volume, cesarean delivery, ovarian reserve

ÖZET

Amaç: Yumurtalık hacmi insanlarda yumurtalık rezervinin dolaylı olarak tahmin edilmesinde kullanılma potansiyeline sahiptir. Bu çalışmanın amacı term gebeliklerde sezaryen doğum esnasında ölçerek yumurtalık hacmini belirlemek ve yumurtalık hacmini anne yaşı ve obstetrik parametreler ile ilişkilendirmektedir.
Yöntem: Sezaryen doğum sırasında yumurtalık gözlemi yapıldı. Her yumurtalığın üç boyutu (en, boy ve derinlik) ölçüldü ve basitleştirilmiş oval yapı formülü ile sağ ve sol yumurtalık hacimleri hesaplandı.
Bulgular: Toplam olarak, 132 araştırmaya uygun hasta bulundu. İki-yönlü ANOVA testi (faktörler: Yaş grubu ve yumurtalık tarafı) genel olarak sağ yumurtalık hacminin daha büyük olduğunu gösterdi ($p<0,05$). Buna rağmen, yumurtalığın tarafı ile yaş grubu arasında anlamlı bir interaksiyon

bulunmadı (p>0,05). Aynı zamanda, Sağ ve sol yumurtalık hacimleri arasında önemli ve güçlü bir ilişki bulundu (r=0,69; p<0,05). Sağ veya sol yumurtalık hacimleri ve obstetrik parametreler arasında anlamlı ilişki bulunmadı (p>0,05).

Sonuç: Sezaryen doğum üreme döneminde yapılan bir ameliyat olduğu için, sağ ve sol yumurtalık hacimlerinin doğrudan ve doğru bir şekilde değerlendirilmesi ve kayıt edilmesi için iyi bir fırsat olabilir. Bulgularımız sezaryen doğum sırasında sağ yumurtalık hacminin sol yumurtalık hacmine göre daha fazla olduğunu desteklemektedir. Yumurtalık hacimlerinin bilinmesi gelecekte ortaya çıkabilecek üreme sorunlarının çözümlenmesinde önemli bilgi sağlayabilir. Yumurtalık hacimleri küçük olan kadınlara yumurtalık rezervi konusunda taburcu edilmeden önce bilgilendirme yapılabilir.

Anahtar sözcükler: Yumurtalık hacmi, sezaryen doğum, yumurtalık rezervi

INTRODUCTION

The ovaries are the paired female pelvic reproductive organs that are located on either side of the uterus within the ovarian fossa, a space that is bound by the external iliac vessels, obliterated umbilical artery, and the ureter[1]. The ovaries are small, oval-shaped, and grayish in color, with an uneven surface. The actual size of an ovary depends on woman's age and hormonal status; adult ovaries measure approximately 3-5 cm (length) by 1.5-3 cm (width) by 0.6-1.5 cm (thickness) during childbearing years and become much smaller and then atrophic once menopause occurs[2]. In early reproductive life, they have a smooth white-pinkish exterior which later in life exhibits increasing numbers of retracted scars and convolutions. A germinal layer coats the entire ovary, made of cuboidal epithelial cells[1].

Palpation of ovaries during gynecological examination is not a reliable way of ovarian sizing. In recent years, transvaginal ultrasound is the most successful technique for ovarian sizing. The ovaries can be seen by ultrasonography throughout the menstrual cycle in normal women and during early pregnancy except in women without normal positioned ovaries due to pelvic disorders. Following the rapid increase in the experience of transvaginal ultrasound, the measurement of ovarian volume has become a quick, reliable, and cost-effective procedure for evaluation of ovaries. In the practice of gynecology and reproductive medicine, the measurements of ovary can be recorded as the values of its two or three dimensions and ovarian volume. Ovarian volume preferred especially in reproductive medicine. Ovarian volume and antral follicle counts may be useful indicators of success of IVF/ICSI and menopause status[3].

The measurement of ovarian size and volume yields important information for gynecology and reproductive medicine specialists: Determination and follow-up of ovarian pathologies, diagnosis of menopause and determination of ovarian reserve in infertility practice. Diagnosis of ovarian reserve is an important challenge in reproductive medicine. Currently, there are no definitive tests for ovarian reserve determination that can accurately predict women's remaining reproductive lifespan[4]. There is no study examining ovaries and measurement of their three dimensions during cesarean delivery. Cesarean delivery provides an important opportunity to determine true ovarian volume in in vivo settings. Because of its variation in shape and configuration, measurement of ovarian size is better measured as volume. The aim of this study was to determine the right and left ovarian volumes measured during cesarean delivery at term pregnancy and to correlate the ovarian volumes with maternal age and obstetric parameters.

MATERIAL AND METHODS

After obtaining Human Ethics Committee-approval of our university, a retrospective chart review was undertaken in our obstetric service to collect demographic and reproductive data and ovarian volume data in women undergoing cesarean delivery at term (≥37 weeks). Subjects with a history of ovarian surgery and pelvic surgery with a potential to reduce ovarian blood flow, or with a history of diabetes mellitus were excluded. We also excluded subjects with incidental presence of ovarian cysts, tumors and other pathological processes.

While cleaning the abdominal cavity before suturing the parietal peritoneum, ovarian exploration was performed to evaluate whether there were ovarian pathologies and if there were no ovarian pathology in right and left ovaries, each ovary was measured in three dimensions, and right and left ovarian volumes were determined using a simplified formula for a prolate ellipse. It is calculated by multiplying the longest dimension of the ovary (in cm) by the two orthogonal dimensions by a factor of 0.523: Ovarian volume=Length (in cm) x width x thickness x 0.523. Right and left ovarian volumes presented according to age subgroups: Less than or equal to 20, 21-25, 26-30, 31-35, and more than 35. Results were expressed as median (min-max). During statistical analyses, ANOVA and correlation tests were used. A p value less than or equal to 0.05 was accepted as significant.

RESULTS

There were total 132 eligible patients in this study. Table 1 presents demographic and obstetric data of the subjects according to the age groups. Overall, height, weight increase and gravidity, parity, and abortion numbers of the age groups were found comparable (p>0.05).

In our study, during ovarian examination, we observed two unilateral para-ovarian cysts, two unilateral endometriomas, one bilateral endometrioma, and one unilateral dermoid cyst. These subjects were excluded from the study group. Figure 1 shows the right and left ovarian volumes of subjects according to the age groups. After comparison of ovarian volumes by two-way ANOVA (factors: Age groups and ovarian side), overall, right ovarian volumes were found significantly higher than left ovarian ones (p<0.05). However, we did not observe any significant interaction between side of the ovaries and the age groups (p>0.05). When we evaluated the left or right side separately, we found no significant difference in volumes among age groups (p>0.05). We found significant strong correlation between right and left ovarian volumes (r=0.69; p<0.05) (Figure 2). There was no significant correlation between the right or left ovarian volumes and obstetric parameters (p>0.05).

Table 1: Demographic and obstetrical data of the subjects.

	Age groups				
	≤20 (n=5)	**21-25 (n=30)**	**26-30 (n=46)**	**31-35 (n=39)**	**>35 (n=12)**
Maternal age (y)	20 (16-20)	23 (21-25)	28 (26-30)	33 (31-35)	39 (36-42)
Gravidity	1 (1-2)	1 (1-2)	2 (1-3)	2 (1-5)	2 (1-5)
Parity	1 (1-1)	1 (1-1)	1 (1-2)	1 (1-3)	1 (1-2)
Abortion	1 (1-1)	1 (1-1)	1 (1-2)	1 (1-3)	1 (1-3)
Maternal height (cm)	165 (154-173)	166 (154-175)	161 (150-171)	164 (156-175)	158 (147-170)
Maternal weight (kg)					
At beginning of pregnancy	63 (44-91)	59 (46-90)	59 (45-81)	61 (52-89)	65 (56-82)
At end of pregnancy	78 (52-91)	72 (61-106)	73 (56-94)	77 (60-109)	80 (63-93)
Weight increase	9 (4-14)	17 (4-25)	15 (8-23)	15 (5-25)	11 (6-28)

Data were presented as median (min-max)

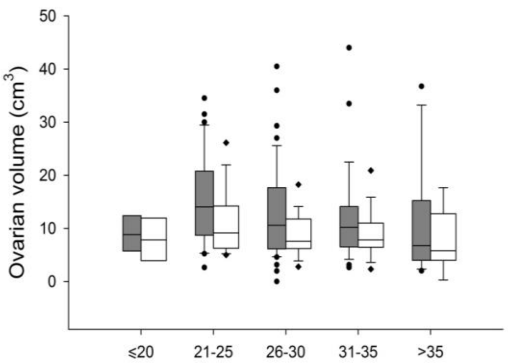

Figure 1: Ovarian volumes of study subjects according to age groups. Data were expressed as median with range. Overall, ovarian volumes of all the age groups were found higher in right side. The ovarian volumes of all the age groups on the right or left side were found comparable. Black boxes present right side and white boxes show left side.

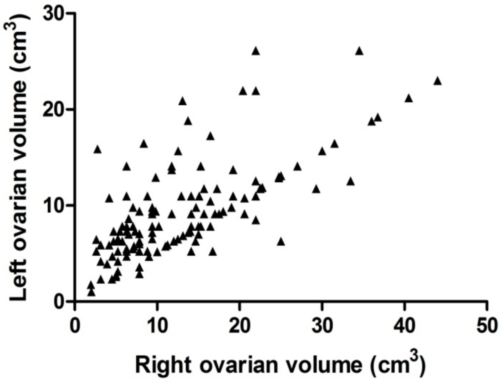

Figure 2: Association of volumes of right and left ovaries. There was significant strong correlation between the right and left ovarian volumes (r=0.69, p<0.05).

DISCUSSION

We found 132 suitable subjects with complete record of demographic, obstetric, and ovarian size data. Age groups (≤20, 21-25, 26-30, 31-35, and >35) were found similar with regard to the gravidity, parity, abortion, maternal height, and maternal weight increase. The association of right and left ovarian volumes was considerable. Of the right or left side, the ovarian volumes did not change meaningfully according to the age groups. Overall, on the right side of all age groups, ovarian volumes were higher than left ones. This situation may be a result of more uterine compression on the right pelvic side because of uterine dextro-rotation compressing right ovarian vein.

During pregnancy there are some conditions increasing ovarian size like corpus luteum of pregnancy and theca lutein cysts accepted as functional, non-tumoral findings. Under the effect of human chorionic gonadotropin, corpus luteum undergoes cystic enlargement. These cysts commonly regress spontaneously and uneventfully by the 12th week of pregnancy. Theca lutein cysts are mostly associated with gestational trophoblastic diseases. In our study, during ovarian examination, we found two unilateral para-ovarian cysts, two unilateral endometriomas, one bilateral endometrioma, and one unilateral dermoid cyst. There are by three ill-defined zones in the ovary: An outer cortex, an inner medulla, and the hilus [5]. The cortex is where the follicles and oocytes are found at various stages of development and degeneration. The cortex is made of tightly packed connective tissue. The stroma of this cortical connective tissue is composed of spindle-shaped fibroblasts that respond to hormonal stimulation in a way different from that of other fibroblasts in the body[1]. The medulla is where the ovarian vasculature is found and is primarily loose stromal tissue[6]. A cross-section of the ovary reveals many cystic structures that vary in size in the cortex. These structures represent ovarian follicles at different stages of development and degeneration[1,7-9].

For each woman, her ovaries contain a determined number of non-growing follicles with a maximal number (approximately 7 million) at her intrauterine life at 18-22 weeks gestation that declines bi-exponentially towards menopause when less than 1,000 non-growing follicles are available at an average age of 50-51 years[10]. At birth, a female has approximately 1-2 million oocytes, but approximately 300 of them have a chance to become mature and to be released for the purpose of fertilization[1]. Recent socioeconomic changes have resulted in an increasing number of women delaying childbirth until later in life, when their fertility is significantly compromised compared to younger women. This causes significant pressure on fertility services and an increases demand for IVF/ICSI[11].

The human ovary is a dynamic organ that continually changes in size and activity through life. At birth, the ovary is approximately 1 cm in length as a flattened organ[2]. There is continuous slow growth of the ovaries throughout childhood, and at the time of puberty, they are in adult size [5]. After the menopause, the ovaries shrink to a size approximately one-half of that seen in the reproductive era. In reproductive period, in each female cycle, the ovaries go through a series of stages as generally alternating every cycle, depending on stimulation by the follicle stimulating hormone and the luteinizing hormone. A typical female cycle lasts 28 days; however, this can range from 21-35 days[1]. The ovarian cycle has two distinct phases: The follicular phase (days 1-14) and the luteal phase (days 14-28). The follicular phase is characterized by follicle development and growth, the goal being that one follicle matures and releases an egg at the time of ovulation, around day 14 of the female cycle. The remaining immature follicles go through stages of degeneration up until day 28, when the cycle repeats itself. The egg that is released is picked up by the fimbriae of the uterine tube, and the egg is transported toward the uterus. If fertilization does not occur, the egg degenerates, and menstruation occurs[1].

Pavlik et al.12 conducted a study to determine the relationship of ovarian volume to age, height, and weight in women undergoing transvaginal sonography. They obtained data from 58,673 observations of ovarian volume. They found that mean ovarian volume was 6.6 ± 0.19 cm^3 in women less than 30 years of age; 6.1 ± 0.06 cm^3 in women 30-39; 4.8 ± 0.03 cm^3 in women 40-49; 2.6 ± 0.01 cm^3 in women 50-59; 2. 1 ± 0.01 cm^3 in women 60-69; and 1.8 ± 0.08 cm^3 in women ≥70. They determined mean ovarian volume as 4.9 ± 0.03 cm^3 in premenopausal women and as 2.2 ± 0.01 cm^3 in postmenopausal women. They concluded that there was a meaningful decrease in ovarian volume with each decade of life from age 30 to age 70 and that mean ovarian volume in premenopausal women is considerably greater than that in postmenopausal women. They found that the upper limit of normal for ovarian volume is 20 cm^3 in premenopausal women and 10 cm^3 in postmenopausal women.

Lass et al.[13] reported that ovarian volume measured on transvaginal sonography are associated with a poor response to ovulation induction by human menopausal gonadotropin for in vitro fertilization. They concluded that there was a strong association between ovarian volume and ovarian reserve and small ovaries were associated with poor response to human menopausal gonadotropin and a very high cancellation rate during in vitro fertilization. They recommended that assessment of ovarian size was a valuable tool as an integral part of infertility evaluation. Gracia et al.[14] investigated whether measures of ovarian reserve differed between females exposed to cancer therapies in a dose-dependent manner as compared with healthy controls of similar age and late reproductive age. They found that exposure to pelvic radiation was associated with impairment in follicle stimulating hormone, anti-Müllerian hormone, antral follicle count, and ovarian volume. They determined that measures of ovarian reserve were impaired in a dose-dependent manner among cancer survivors compared with unexposed females of similar age. Ben-Haroush et al.[15] investigated the value of subpopulations of small (2-5 mm) and large (5-10 mm) antral follicle count, ovarian volume, and ovarian stroma Doppler indices as predictors of pregnancy in in vitro fertilization. They suggested that pretreatment small antral follicle count and ovarian volume might identify women with a higher probability to achieve pregnancy in in vitro fertilization. Kwee et al.[16] compared the antral follicle count and basal ovarian volume, the exogenous FSH ovarian reserve test and the clomiphene-citrate-challenge test, with respect to their ability to predict poor and hyper-responders. They found that the ovarian volume produced no meaningful finding in terms of predicting low or hyper-response.

Jonard et al.[17] conducted a study to revisit the ovarian volume as a diagnostic criterion for polycystic ovaries in PCOS patients. They concluded that measurement of the ovarian volume provided good diagnostic accuracy to distinguish normal ovaries from polycystic ovaries. In their study, the best compromise between sensitivity and specificity was obtained with a threshold set at 7 cm^3, instead of the 10-cm^3 threshold proposed by the Rotterdam consensus conference because of empirical assessments[18]. Carmina et al.[19] followed-up young women with polycystic ovary syndrome for 20 years to determine whether hormonal, metabolic and anthropomorphic parameters change during that period. They found that androgens and ovarian volume decreased and that there were more ovulatory cycles suggesting a milder disorder, whereas metabolic abnormalities persisted and waist circumference increased. Liang et al.[20] compared the clinical and biochemical presentation of polycystic ovary syndrome in women between the ages of 20 and 40. They found that the average ovarian volume was not significantly different between the two groups.

There are several examples of controversies and conflicting evidence based on ultrasound ovarian measurement. The use of 3D ultrasound techniques does not appear to increase the predictive power of ovarian volume as a screening tool for response to ovarian stimulation[21]. There is a considerable correlation between primordial follicle population and ovarian volume as reported by several authors[22,23] and it has been proposed that transvaginal measurement of ovarian volume may be used to evaluate ovarian reserve[23]. Brett et al.[21] evaluated the precision of ovarian volume measurements by 2D and 3D transvaginal ultrasound scan using three appropriate statistics: Inter-class correlation, standard error, and coefficient of repeatability and therefore quantify the precision of measurements of ovarian volume for individual women rather than for populations. They found that the measurement of ovarian volumes by both 2D and 3D techniques provided high inter- and intra-class correlation. They concluded that both methods suffered from a lack of precision, which was greater for lower ovarian volumes. According to their decision, that had important implications for clinical practice, and might explain inconsistencies in the literature for studies in which the measurement of ovarian volume is an important factor. They recommended that since individual measurements of ovarian volume could be imprecise and of doubtful clinical value the possibility of measurement error should be taken into account when making clinical decisions and an average of multiple measurements (either by the same observer, or by different observers) was likely to give a more accurate estimate of the true ovarian volume. Bozdag et al.[24] investigated the correlation of 2-dimensional (2D) and 3-dimensional (3D) ultrasonography with true ovarian volume, as calculated precisely after oophorectomy. They found that the correlation coefficients of 2D and 3D of ultrasonography with true ovarian volume as measured after oophorectomy were similar (0.65 vs. 0.67, respectively). After the agreement analyses of 2D and 3D ultrasonography with true ovarian volume, they concluded that while estimation by 2D USG brought 18% larger, 3D USG revealed 11% smaller ovarian volumes than the true ovarian volume. In another study conducted by Rosendahl et al.[25], a possible difference between true ovarian volume and ovarian volume estimated with 2D transvaginal ultrasound was determined.

They measured the true ovarian volume before oophorectomy. They found that ovarian volume obtained by ultrasound was at least 27% smaller than the true ovarian volume. They concluded that ovarian volume was severely underestimated by transvaginal 2D ultrasound measurement.

In conclusion; there is continuing debate regarding the best measurement technique for determination of ovarian volume with imaging techniques. Cesarean delivery is an operation performed during reproductive period can be an opportunity to evaluate and to record the right and left ovarian volumes directly and correctly. The fact that the right ovarian volume can be found higher than left one needs to be kept in mind. The information about the ovarian volumes may provide important information to solve future reproductive problems. In women with small sized ovaries, information about her ovarian reserve can be given before her discharge.

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