Original Article

Morphological and morphometric parameters of human ovaries from embryonic to menopausal age

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Abstract

Background: There is a relationship between the intrauterine development, pubertal and adulthood variations, anomalies, and pathology of ovaries. But the entire development spectrum of the ovaries from fetal to menopausal age has not been examined among Indian females. **Objectives:** This study was conducted with an objective to establish the morphological and morphometric development characteristics of ovaries in local population as a proxy for Indians. **Materials and Methods:** Thirty ovaries from prenatal embryos and fetuses aged 6 weeks to 40 weeks and 50 postnatal ovaries up to 55 years of age were studied for morphology and morphometry, by doing dissection. **Results:** Oval shape was predominant in prenatal ovaries (66.68%), followed by rod (20%), almond, and "S" shapes (6.66% each). Among the postnatal ovaries while almond shape accounted for 72%, the incidence of oval shape was 28%. There was a significant correlation between gestational age and weight of the ovaries both in prenatal (r = 0.56) and postnatal (r = 0.696) specimens studied. **Conclusion:** Variations in the morphological and morphometric development characteristics of ovaries are common. The findings of this study form an initial database for the local population which may be improved in the subsequent studies.

Key words: Morphology, morphometry, prenatal, postnatal

Introduction

Ovaries nurture eggs and produce several steroids and peptide hormones that play major role in regulation of reproductive cycle, maintenance of gestation, and initiation of parturition. There is a relationship between the intrauterine development, pubertal and adulthood variations, anomalies, and pathology of ovaries.[1]

Genetic sex of the embryo is determined at the time of fertilization, but the gonadal sex is not specified before 7th week.[2] The developmental components of female gonad are coelomic epithelium (gonadal ridge) on the medial side of mesonephric ridge, underlying mesenchyme and the primordial germ cells that migrate from caudal end of yolk sac. The middle part of gonadal ridge contributes for the gonadal development, whereas cranial part becomes suspensory ligament of the ovary and caudal part becomes ovarian ligament.[3] During first trimester of development, the fetal ovaries are located on the posterior abdominal wall and descend to pelvis as development progresses.

The knowledge of ovarian morphology and morphometry is useful in understanding reproductive cycles and/or malformations of external genitalia. Most of the published studies on ovarian morphology and morphometry are on small samples and limited to specific ages. The entire development spectrum from fetal to menopausal age has not been studied among Indian females in any single study earlier. Thus, this study was conducted with an objective to establish the morphological and morphometric development characteristics of ovaries in local population as a proxy for Indians. Observations by anatomical dissection provide more detailed information than ultrasonography. Accordingly, this study followed the dissection method.

Materials and Methods

A total of 80 ovaries (30 prenatal and 50 postnatal)

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collected from dead fetuses, adult cadavers, or during surgical oophorectomy were studied. Aborted fetuses received from the maternity hospital with case history and without apparent malformations were used in this study. External features, weight, crown–rump length, and crown–heel length were recorded. Postnatal ovaries used in this study were from patients who underwent oophorectomy but without ovarian pathology or accident victims having intact ovarian structure. Informed consent was obtained from patients/close family members. The study was approved by the institutional ethics committee.

Formalin (10%) was injected into abdominal, thoracic, and cranial cavities as well as limbs of the fetuses and preserved for 3 days. A para-median incision along the abdominal/pelvic cavities exposed the fetal ovaries. The ovaries were observed for their position, shape, appearance, and color. They were separated from broad ligament, and the length, width, thickness and weight were recorded. Morphometric parameters of the two smallest embryos in this group (6 week and 8 week old) were, however, recorded in serial sections using eye piece micrometer.

The postnatal specimens were studied immediately after collection at autopsy or surgery and all observations as in the prenatal group were also recorded in this group.

Results

All the prenatal ovaries were at the pelvic brim except in the two smallest embryos where they were located in the lumbar region. In all the postnatal specimens, ovaries were located in the pelvic cavity. Different shapes of ovaries like rod shape, "S" shape, oval shape, and almond shape [Figure 1] were observed in varying frequencies in prenatal and postnatal groups [Table 1].

While prenatal and pre-pubertal ovaries presented a smooth surface [Figure 1b], postpubertal ovaries were irregular and puckered [Figure 1c]. Prenatal and postnatal ovaries were dull white, pink [Figure 1b] yellowish or gray [Figure 1c] in color.

In both prenatal and postnatal age groups, there was no difference in shape on right and left sides. In one case, however, it was rod shape on right side and S shape on left side [Figure 1a]. Right ovary in the cadaver of a pregnant woman aged 25 years showed a prominent corpus luteum on the surface measuring 1.8 × 1.0 cms [Figure 1c].

There was a significant correlation between gestational age and the weight of ovary in the prenatal ($r = 0.56$; $P < 0.05$) and postnatal ($r = 0.696$; $P < 0.05$) groups [Table 2].

Discussion

The entire spectrum of ovarian development from fetal to menopausal age was not examined among Indian females earlier. Published reports had sparsely mentioned the sample size and the age groups studied.[1,4] This study on 80 ovaries is the first to report on human ovarian morphology and morphometry starting from 6 weeks gestational age to 55 years postnatal period. The only published study on morphology and morphometry of ovaries on large sample size was that of Osman Sulak *et al* (2006) on 71 fetuses of 9 – 40 weeks gestation.[1]

While the location of adult ovaries is described in standard text books, such information on prenatal and pre-pubertal ovaries is scarce. In this study, all prenatal ovaries were located at the pelvic brim except the two smallest embryos in which they were in the lumbar region. In the postnatal age group, pre-pubertal ovaries crossed the pelvic brim and the post-pubertal ones were located in the pelvic cavity. Osman Sulak *et al* (2006) reported trimester-wise variations in the location of the fetal ovaries starting from the pelvic brim indicating a gradual descent with progress in gestational age. Further, they also reported differences in the descent of right and left ovaries. In this study, however, such differences were not observed probably owing to the differences in origin of the samples and the methods of the study. In the prenatal group, the ovaries were placed transversely and in postnatal group in oblique or horizontal position. Variability in position has been reported to be due to the state of surrounding organs.[5]

In the prenatal group, the predominant shape was oval [Table 1] in all the three gestational age groups studied. In the only other report on the morphology of prenatal ovaries,

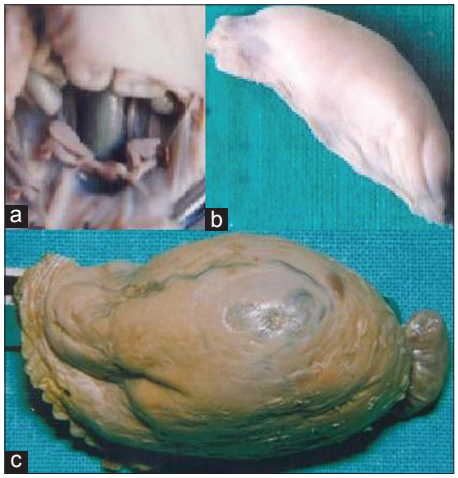

Figure 1: (a) Fetal ovaries: right ovary - rod shape; left ovary - "S" shape; (b) pre - pubertal ovary: oval shape; (c) reproductive age ovary: almond shape with a surface projection of preovulatory follicle.

Osman Sulak *et al* (2006) reported predominance of almond shape in Turkish fetuses. In the postnatal specimen, almond shape predominated in this study [Table 1]. There are no reports on percentage incidence of various ovarian shapes available in literature, although almond and oval shapes have been reported.[1, 6]

All pre-natal and prepubertal ovaries presented smooth surface although small furrows were observed in some of the specimen of fetal period, also reported in earlier studies. [3] Post-pubertal ovaries were either irregular or scarred. This was presumably due to repeated ovulations and degeneration of corpora lutea, as reported in earlier studies.[3,6,7] Post-menopausal ovaries were shrunken and the surface presented depressions due to scarring. The observations on color of ovaries in this study are in agreement with the only earlier report on this particular morphological parameter.[7]

The observations in this study on length, width, and thickness of ovaries [Table 2] are comparable with earlier reports [Table 3]. The average length of ovaries obtained in this study from the fetuses of 18–36 weeks gestational age [Table 2] is less than the value reported in the literature.[8] Further, the length of the ovaries in this study is not constant against an earlier report.[8] However, the lengths of the ovaries during this period in this study are in agreement with that reported by Osman Sulak *et al*.[1] Similarly, the increase in width and thickness of the

Table 1: Frequency distribution of different shapes of ovaries

Period with age	Frequency distribution of different shapes, n (%)			
	Rod shape (%)	Oval shape (%)	Almond shape (%)	S shape (%)
Prenatal ovaries (gestational age in weeks)				
6–12	Nil	4 (100)	Nil	Nil
13–28	4 (25)	12 (75)	Nil	Nil
29–40	2 (20)	4 (40)	2 (20)	2 (20)
Postnatal ovaries (age in years)				
0–15	Nil	4 (66.6)	2 (33.3)	Nil
16–30	Nil	4 (28.6)	10 (71.4)	Nil
31–45	Nil	5 (22.7)	17 (78.2)	Nil
46–55	Nil	Nil	8 (100)	Nil

Table 2: Morphometric parameters (average) of prenatal and postnatal ovaries

Period with age	Length (mm)	Width (mm)	Thickness (mm)
Prenatal ovaries (gestational age in weeks)			
0–12	6.0	4.0	1.5
13–28	11.5	3.4	1.0
29–40	17.0	4.2	1.8
Postnatal ovaries (age in years)			
0–15	28.83	12	7.5
16–30	33	19.92	13.61
31–45	34.27	22.91	13.13
46–55	34.75	22.75	15.25

Table 3: Ovarian morphometry (comparative literature values)

Category	Length (mm)	Width (mm)	Thickness (mm)	Author
9 weeks embryo	3	1	0.5	Osman sulak *et al*. (2006)[1]
20 weeks	9.25 - 10.50	2.44 - 3.84	2.03 - 2.09	Sforza *et al*. (1993)[4]
25 weeks	11.00	3.20	1.68	Sforza *et al*. (1993)[4]
40 weeks	19.0	6.0	2.0	Osman Sulak *et al*.(2006)[1]
Newborn	9.05 - 16.98	3.45 - 6.92	2.34 - 5.18	Sforza *et al*. (1993)[4]
Full - term	9 - 17	3.5 - 7	2.5 - 5	Forabosco *et al*. (1991)[9]
Neonate	13.0	6.0	4.0	Healy *et al*. (2008)[5]
8 months	12.30	7.90	5.13	Sforza *et al*. (1993)[4]
Reproductive age	40.0	20.0	30.0	Healy *et al*. (2008)[5]
Pregnancy	Double	Double	Double	Healy *et al*. (2008)[5]
Multipara	25 - 50	15 - 30	6 - 15	Raviola (1986)[10]
Early menopause	20.0	15.0	6.0	Healy *et al*. (2008)[5]
Late menopause	15.0	7.5	5.0	Healy *et al*. (2008)[5]

ovaries during this period in this study is not significant in contradiction to an earlier report.[1]

The average width and thickness decreased in the 13-28 week gestational age group in this study. No such observation was reported earlier. The decrease in width and thickness could be due to the increasing number of degenerating follicles or reduced space in the abdominal cavity due to expansion of vital organs such as kidney, liver, or gut.

In the postnatal age group, there is a gradual increase in length, width, and thickness with advancing age [Table 2]. There is no decrease in size of ovaries from reproductive to menopausal ages in this study [Table 2], although such a decrease was reported in the literature.[5, 10]

The combined weight of ovaries at birth ranges between 40 and 295 mg. [3,4,10] Our observations on weight of ovaries are in agreement with that reported in the literature.[3,4]

There is a significant correlation between gestational age and weight of prenatal (r = 0.56; P < 0.05) and postnatal (r = 0.696; P < 0.001) ovaries in this study. Except for the report of Osman Sulak *et al*, (2006), there were no earlier reports on the correlation of ovarian weight with age. The observations on ovarian weight in prenatal age group in this study are higher than those reported by Osman Sulak *et al* (2006), which may be ascribed to differences in the origin of specimen. The findings of this study form an initial database for the local population which may be improved in the subsequent studies.

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