Development of the fetal uterus between 19 and 38 weeks of gestation: in-utero ultrasonographic measurements*

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In-utero assessment of the internal female genitalia is important for determination of fetal gender in fetuses with suspected genital tract anomalies. We therefore measured fetal uterine transverse width and circumference from 19 weeks of gestation until term, using transvaginal and transabdominal high-resolution ultrasound techniques in order to establish nomograms. A prospective, cross-sectional study on 180 normal singleton pregnancies was performed. Data were obtained for 140 normal fetuses. The mean ± SD uterine width and circumference were 12.9 ± 4.1 mm (95% confidence interval 12.1–13.7), and 40.2 ± 12.5 mm (95% confidence interval 37.9–42.5) respectively. Uterine size as a function of gestational age was expressed by the regression equations: uterine width (mm) = 12.9 + 0.7 × gestational age (weeks), and uterine circumference (mm) = 40.2 + 2.1 × gestational age. The correlation coefficients, r = 0.885 and r = 0.888, for uterine width and circumference, by gestational age respectively, were highly statistically significant (P < 0.001). A nomogram of uterine width and circumference per gestational week, and the 95% prediction limits were defined. The present data offer baseline measurements of the fetal uterus that may allow intraterine assessment of the female genital tract and associated fetal gender.

Keywords: fetal uterine measurements/ultrasonographic studies

Introduction

Ultrasonographic diagnosis of fetal gender is not performed merely to satisfy parental curiosity, but plays a major role in the evaluation of normal fetal sexual development. Female genital abnormalities may represent a single organ malformation, or occur in association with other organ malformations due to various genetic syndromes, or endocrinological defects (Jones, 1988). Benign female genital tract abnormalities such as hydrometrocolpos can also be determined (Chen et al., 1988). Ultrasonic visualization of the fetal gender is possible from the early second trimester by identifying the phallus with typical sagittal inclination, and later by demonstration of the labia and clitoris (Emerson et al., 1988). Recently, developments in ultrasound technology have facilitated visualization of more complex abnormalities, such as ambiguous genitalia (Sivan et al., 1995). Although the diagnosis of fetal gender has been widely reported, no biometric data of the normal development of the fetal uterus exist in the literature. Recently, we evaluated fetuses at risk of congenital genital abnormalities. In view of the lack of data, we felt it necessary to establish the normal growth pattern of the fetal uterus.

The aim of the present study was therefore to undertake a prospective, cross-sectional assessment of uterine measurements in apparently normal fetuses.

Materials and methods

The study population comprised 180 pregnant women, with a history of regular 28-day cycle menses, and known date of the first day of the last menstrual period. Only singleton pregnancies with a healthy fetus and neonate that had no known risk factors for abnormal genital tract were included. Multiple gestation and anomalous fetuses detected at the time of sonography, or after birth, were excluded from the study. All gestational ages calculated according to the first day of the last menstrual period were in agreement with the expected crown-rump length measured ultrasonographically in the first trimester. The fetal uterus was measured successfully in 140 consecutive women who met with our inclusion criteria, and were undergoing routine ultrasound examination at the Chaim Sheba Medical Center. In Israel, routine ultrasonographic examination is an integral part of antenatal care. Most of the patients have their initial scan during the early second trimester at 15–18 weeks gestation, and a backup transabdominal examination at 22–26 weeks gestation. A third examination is performed during the third trimester for the estimation of fetal weight and well being. The study was cross-sectional, and each patient was evaluated only once. All the measurements were made by two observers (D.S., R.A.). Ultrasonicographic measurements were made by transvaginal transducer (6.5 MHz), and by transabdominal (3.5–5 MHz) curvilinear transducers (Synergy Diasonics, Haifa, Israel). Freeze-frame ultrasound capabilities and electronic on-screen calipers were used for fetal uterine measurements. All women provided their verbal consent for participation in the study.

In most cases the uterus was measured by a transverse axial scan through the fetal pelvis at the fetal bladder level. However, transvaginal sonography was performed in cases where the fetal pelvis was deeply located in the maternal pelvis. Probe orientation was readjusted during continuous viewing until the maximal diameter of the uterus could be determined. The transverse diameter of the fetal uterus was measured from outer edge to outer edge. The circumference was measured by drawing a continuous line around it, using electronic calipers (Figure 1). Each uterus was...
Figure 1. Ultrasonographic view of the fetal pelvis in a transverse section at 25 weeks of gestation. Note the rounded-shape, echogenic uterus (U) situated between the two hypoechoic structures, R = rectum; B = bladder. A. Measurements of uterine width (UW) = 1.10 cm. B. Measurements of uterine circumference (UC) = 3.45 cm.

Results
A transverse, axial ultrasonographic view through the fetal pelvis was found to be optimal for evaluation of fetal uterus dimensions in 140 of 180 fetuses studied. However, in 40 fetuses evaluation was not possible due to suboptimal position or early gestational age. The uterine width and circumference were measured adequately in all 140 fetuses. The intra-
Sonographic measurements of the fetal uterus

Figure 2. Individual scatter plot showing the relationship between the uterus width in millimetres and gestational age of 140 normal fetuses.

Figure 3. Individual scatter plot showing the relationship between the uterus circumference in millimetres and gestational age of 140 normal fetuses.

and inter-observer repeatability of uterine measurements, as determined by coefficient of variance was 13% (3% ± 0.39) (mean ± SD) and 11% (2% ± 0.4) respectively. The mean ± SD uterine width and circumference were 12.9 ± 4.1 mm [95% confidence interval (CI) 12.1–13.7] and 40.2 ± 12.5 mm (95% CI 37.9–42.5) respectively.

Figures 2 and 3 show the association between uterine width and circumference, and gestational age which appeared to be linear. The regression equation for uterine width as a function of gestational age was $y = 12.9 + 0.7x$ gestational age (weeks), where $y$ represents the fetal uterine width (in mm). For uterine circumference, the regression equation was $y = 40.2 + 2.1x$ gestational age, where $y$ represents the fetal uterine circumference (in mm). The correlation coefficients $r = 0.885$ and $r = 0.888$ for uterine width and circumference respectively were found to be highly statistically significant ($P < 0.0001$). The calculated mean and upper and lower 95% CI limits of the uterine width and circumference per week at gestational age between 19 and 38 weeks were defined, and are shown in Tables I and II.

During the study period, two fetuses with ambiguous genit- alia were evaluated. In the first case, no uterus could be identified and chromosomal evaluation showed XX/XY mosaicism. In the second case, a normal uterus was identified at 26 weeks of gestation and urorectal septum malformation sequence was diagnosed postnatally.

### Discussion

The present study demonstrates that the fetal uterus can be identified at 19 weeks of gestation. The biometry was found to be feasible, with minor inter-observer variation, and therefore high reproducibility. Fetal uterine measurements were easily obtained in 140 of 180 (77.8%) women: the suboptimal position of the fetus, or ultrasonographic examination before 19 weeks gestation were the reasons that fetal evaluation was not possible. High correlation coefficients ($r$ values) were found between uterine size and gestational age.

Little data exist in the literature concerning the normal development and appearance of fetal uterus on ultrasonographic view. With the recent improvement in ultrasound technology,
fetal uterine measurements are possible during the fetal survey. When ambiguous genitalia, or renal and urinary anomalies are detected during fetal life by ultrasonography, it is of importance to identify the existence of a fetal uterus. The uterus is created by fusion of the Müllerian ducts by the 10th week of gestation. In the 20th week of pregnancy, the uterine mucosa is fully differentiated into the endometrium (Arey, 1974). Complete absence of the uterus is rare and always coupled with absence of a vagina. More frequently, the uterus is hypoplastic or represented by a small, solid mass. Pfeiderer (1929) found 14 cases of solid uterus and vagina among 93 uterine anomalies. Aplastic uterus may be more frequent than reported, because most anomalies are reported by obstetricians, who rarely see patients with a non-functional uterus. Most cases of Rokitansky anomaly are sporadic, but about 4% of cases have been familial, with affected female siblings (Jost et al., 1973). Novak (1917) suggested a high familial incidence from findings in several families in which sisters suffered from uterine aplasia. Winter (1968) reported four sisters: three had Müllerian agenesis, all had unilateral or bilateral renal agenesis, and two had conductive deafness. The Rokitansky malformation sequence may be a part of a broader pattern of malformation. Uterine anomaly can be found in Fraser and trisomy 13 syndromes (Fraser, 1962). No abnormality involving sex chromosomes is known (Azoury and Jones, 1966).

Mukerje (1980) measured human uteri after therapeutic abortion and stillbirths and showed a linear growth. Conversely, Pietryga and Wozniak (1992) concluded that the uterus grows intensively between 16 and 24 weeks of gestation. Their studies were not carried out on normal pregnancies and did not use ultrasonographic modalities. However, we found that there is a linear growth of the fetal uterus, from 19 to 38 weeks of gestation. We recommend the use of the present nomograms in patients at risk of congenital uterine anomalies, including uterine agenesis, or in cases of suspected genital malformation.

References


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