Growth of the uterus

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Abstract

Background—The pattern of growth of the uterus was examined by ultrasound examinations of 358 girls who attended a paediatric endocrine outpatient department but were shown not to have any endocrine defect.

Method—The uterus was measured in length and width at the cervix and at the fundus (cm). Endometrial thickness was measured (mm). Scans were divided by Tanner breast stage and the dimensions compared by one way analysis of variance (ANOVA, with the Student Newman Keuls post hoc test).

Results—There was an increase in uterine length, diameter of the fundus, and endometrial thickness at each breast stage from 1 to 5 (ANOVA, $p < 0.05$), and in the diameter of the cervix with each breast stage from 1 to 4 (ANOVA, $p < 0.05$). The ratio of the fundus to the cervix increased from 0.95 to 1.29 between breast stages 1 and 4.

Conclusion—The onset of puberty is marked by an increase in the dimensions of the uterus and in endometrial thickness, but also by a change in the shape of the uterus from a tubular to a pear shaped organ.

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Ultrasound is painless and non-invasive, and even in infants can determine the dimensions of the uterus and ovaries. Endometrial and myometrial cells are oestrogen responsive^{1,2} and the uterus increases in size during puberty. Information on uterine size and shape and on the thickness of the endometrium are useful in the assessment of girls with sexual precocity and pubertal delay. Published data on the pattern of growth in normal individuals are limited.³⁻⁵ We have examined the dimensions of the uterus in a large group of girls with no endocrine defect.

Methods

SUBJECTS

The girls studied had attended the paediatric endocrine outpatient department at the Middlesex Hospital but turned out to have no endocrine disorder and were on no treatment; they ranged in age from birth to 16 years. There were 475 scans on 358 girls.

ULTRASOUND SCANS

Transabdominal ultrasound scans were performed. A full bladder was required to image the pelvic organs. At each scan, the uterus was measured in three dimensions (in cm): length (from top of the fundus to the cervix), diameter

at the fundus, and diameter at the cervix. The cervical diameter was not routinely measured when the uterus was an adult size. The thickness of the endometrium was measured (in mm). Puberty was staged by the method of Tanner,⁶ and menarche was recorded.

REPRODUCIBILITY OF ULTRASOUND MEASUREMENTS

To determine the reproducibility of linear measurements made at ultrasound, six ultrasound examinations were performed in duplicate. Examinations were performed by two experienced ultrasonographers on six individuals at the same occasion, with the second examiner 'blind' to the results of the first examination. The coefficient of variation (CV) ranged from 0 to 32.0%. Plotting the difference between pairs against the mean of the pairs (the Bland-Altman plot⁷) demonstrated a trend for greater errors in the larger measurements (equation of line: difference = 0.08 (mean) - 0.07; correlation coefficient = +0.57).

ANALYSIS OF DATA

The scans from the patients were divided by Tanner breast stage. Mean values for the measurements made at each pubertal stage were calculated and compared by one way analysis of variance (ANOVA, with the Student Newman Keuls post hoc test). The ratio of the diameter at the fundus and the cervix was calculated for each scan, and a mean ratio calculated for each pubertal stage. The length measurements for the scans at breast stage 1 were plotted against age and a regression line calculated.

Results

Table 1 shows the numbers in each group, the ratio of fundus to cervix and the endometrial thickness, divided by pubertal stage. Figure 1 shows the uterine dimensions (SE) according to Tanner breast stage. ANOVA demonstrated an increment in uterine length, fundus diameter, and endometrial thickness at each breast stage from 1 to 5 ($p < 0.05$), and in the diameter of the cervix with each breast stage from 1 to 4 (ANOVA, $p < 0.05$). Figure 2 shows the measurements of uterine length at breast stage 1 plotted against age. The equation of the best fit line was length = 0.093 (age) + 2.67; $r = 0.50$. This line cannot be extrapolated to 0 years, because numbers at this age are insufficient. The uterus is probably larger in the immediate postnatal period than later in infancy because of the effect of neonatal and maternal oestrogen secretion.

There was no difference in endometrial thickness or uterine dimensions between girls at breast stage 4 or 5 who had menstruated and those who had not.

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Figure 1 Graph showing mean (SE) uterine length and diameter at the fundus and cervix by breast stage.

Discussion

Ultrasound measurements of the uterus made by experienced operators are highly reproducible. It is technically easier to measure the uterus than the ovaries in children and linear ultrasound measurements are more reproducible than volume measurements.⁸

During childhood the uterus grew in length (fig 1), with diameters at fundus and cervix remaining approximately equal prepubertally. Somatic growth of ovarian volume during childhood was also observed in the same group of subjects.⁸ The increasing concentrations of circulating sex steroids during puberty resulted in growth and a change in shape. Growth in diameter at the fundus outstripped growth in diameter at the cervix and resulted in a pear shaped configuration. A similar change in uterine shape with puberty was documented by Griffin *et al* in a group of 153 girls.⁵

An increase in endometrial thickness was another marker of pubertal progress, although a thin endometrium was seen in some prepubertal girls, perhaps stimulated by the very low concentrations of oestrogen found in prepuberty. Measurement of endometrial thickness was no more helpful in predicting the time of onset of menstruation than pubertal rating. The mean endometrial thickness in girls who had menstruated but were not ovulating was thinner than that observed in older women during ovulatory cycles (a mean of 12.1 mm

Table 1 Age, number of patients, fundus: cervix ratio, and endometrial thickness divided by breast stage

Breast stage	Mean age (years)	No	Mean ratio of fundus: cervix (SE), range	Endometrial thickness (mm) (SE), range
1	8.6	245	0.95 (0.02) 0.44-1.75	0.38 (0.07) 0-4
2	11.3	112	1.12 (0.31) 0.55-2.00	1.02 (0.15) 0-6
3	11.8	57	1.26 (0.04) 0.77-2.00	2.79 (0.28) 0-8
4	13.3	34	1.29 (0.06) 1.0-1.83	5.04 (0.63) 2-17
5	13.9	27	1.22 (0.09) 0.75-2.13	6.44 (0.81) 0-15

during the luteal phase in one study of normal women aged 21 to 25 years⁹).

There was considerable overlap in dimensions between pubertal stages. This study suggests that uterine shape was a better marker of pubertal development than uterine dimensions. The data are cross sectional and do not give information about the pattern of growth to be expected in an individual. Uterine growth may not follow along centile lines in the same manner as height. While the assessment of pubertal changes at ultrasound may be of importance in some conditions (for example in assessing girls with sexual precocity), the importance of relative uterine size at any pubertal stage on future development is not clear. Our group included individuals with heights above the 97th centile and below the 3rd centile (unlike those in the study of Griffin *et al*⁵). There are no data on the relationship between height and uterine dimensions, but it may be that shorter girls have smaller uterine dimensions.

The onset of breast development at puberty is marked by uterine growth. A change in the shape of the uterus with growth in the diameter at the fundus overtaking growth at the cervix (adopting a pear shape) is a marker of puberty.

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Figure 2 The measurements of uterine length at breast stage 1 plotted against age. The equation of the line was length = 0.093 (age) + 2.67; r=0.50.

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