Original Study

Differences in Anthropometric and Ultrasonographic Parameters between Adolescent Girls with Regular and Irregular Menstrual Cycles: A Case-Study of 835 Cases

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A B S T R A C T

Study Objective: Exploring the relation between the age, time since menarche, anthropometric parameters and the growth of the uterus and ovaries in postmenarcheal girls.
Design: Cross sectional.
Setting: Department of Human reproduction at a tertiary pediatric referral center.
Participants: Eight hundred thirty-five adolescent girls.
Interventions: Postmenarcheal girls were classified according to the regularity of their menstrual cycles in 2 groups (regular and irregular cycles) and compared. Anthropometric measurements and ultrasonographic examination of the pelvis was conducted with all participants.
Main Outcome Measures: Anthropometric and ultrasonographic parameters were evaluated.
Results: Results of our study showed that girls with regular and irregular cycles differed in height, weight, body mass index, percentage of body fat and ovarian volumes. The size of the ovaries decreases in the group of girls with regular cycles ($r = 0.14$; $P < .005$), while it increases in girls with irregular cycles ($r = 0.15$; $P < .001$) with advancing age. Uterine volume in all patients increases gradually with age reaching consistent values at 16 years ($r = 0.5$; $P < .001$). Age at menarche, the time elapsed since menarche, the height, weight, body mass index and percentage of body fat in patients correlated with uterine volume. Ovarian volume correlated with patients' weight, BMI and percentage of fat.
Conclusion: Uterus continues to grow in postmenarcheal years, with increasing height and weight of girls, regardless of the regularity of cycles. Postmenarcheal girls with irregular cycles were found to have heavier figures and larger ovaries.
Key Words: Adolescents, Uterus, Ovary, Growth, Anthropometry, Menstrual cycles, Body composition, Ultrasonography

Introduction

Adequate pubertal growth of the genital organs is essential for reproductive health of a girl.[1] The development of the female reproductive system from birth until menarche is well documented.[2,3] On the other hand, fewer data are available on morphologic changes and growth patterns of the uterus and ovaries during the first few years after menarche.[1,4]

It has been suggested that after the menarche uterus continues to grow and gradually reaches the adult size and form.[1] This process is thought to be completed by the age of 16.[4,5] An ovary, in the immediate premenarchal period, enlarges rapidly and attains, by menarche, the adult appearance.[5] After menarche, the ovarian/uterine ratio decreases with increasing gynecologic age.[1] Among the reproductive hormones, estradiol seems to be the main agent stimulating uterine growth. Other reproductive parameters, such as the regularity of menstrual bleeding, regularity of ovulation and progesterone levels, do not appear to be related to uterine size and growth rate.[1]

The imaging technique of choice for studying the pelvic organs in adolescent girls is real-time ultrasonography (US) because it is noninvasive, painless and free of ionizing radiation.[1] Transabdominal US is the approach of choice for non sexually active adolescents[2] and provides an optimal overview of the anatomy, shape, size, and echogenicity of the pelvic organs.

The aim of this study was to explore postmenarcheal development of the uterus and ovaries. We studied the relation between age, time since menarche, antrophometric parameters and the volume and size of the uterus and ovaries in a population of girls with regular and irregular menstrual cycles.

Methods

Study Design and Participants

A cross sectional study on 857 postmenarcheal patients (postmenarcheal period ranged from 6-72 months) was conducted from July 2008 to January 2013.

The authors indicate no conflicts of interest.

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Adolescents were selected based on the following criterion: the ultrasonographic presence of the uterus and both ovaries. The exclusion criteria were: endocrinopathies (hypo/hyperthireoidism, hyperprolactinemia, diabetes mellitus); evidence of congenital adrenal hyperplasia or androgen-secreting tumors; cardiovascular or other systemic diseases; chromosomopathies; ovarian cysts and tumors; suspicion of ovarian torsion; malformations of the internal genital organs; nutrition disorders and current use of medications known to alter reproductive hormones (hormonal contraceptives, progesterone therapy, insulin sensitizers and antihypertensive medications).

Menstrual cycles were defined as either (1) regular, if their length was 22-35 days, or (2) irregular, when they were less than 22 or more than 35 days long.[6]

The study protocol was approved by the Ethic Committee of the Mother and Child Healthcare Institute. Signed informed consent was obtained from all participants and/or their parent or legal guardian before participation in the study.

Procedures

At the examination each subject had a protocol consisting of anthropometric measurements and ultrasonographic evaluation of the ovaries and uterus.

Postmenarcheal patients were grouped into 2 distinct groups. First group consisted of patients with menstrual irregularities (IC) and the second group comprised of patients with regular cycles (RC). Data distribution regarding age and time since menarchae did not show statistically significant differences, thus our groups had homogenous distribution.

Ultrasonographic Examination

Transabdominal ultrasonographic examination of the ovaries and uterus was performed during the early follicular phase of the cycle (day 1-6), or on a random day of a cycle (at least 3 months of amenorrhea) for the amenorrheic patients. The examinations were conducted by 1 sonographer in all cases, using MyLab 50 Xvision scanner equipped with CA631 convex probe (8-1 MHz). Transabdominal US was performed in all the cases, with a patient in dorsal decubitus and with a full urinary bladder. The uterine and ovarian volumes were calculated using the formula for ellipsoid bodies (volume equals to 0.523 × length × width × height of the organ), and expressed in cubic centimeters. The study included 835 out of 857 patients in whom uterus and both ovaries were identified. In remaining 22 cases only 1 ovary was visualized, and we excluded those patients from data analysis.

Anthropometric Measurements

Patients had a height measurement (in meters) to within ± 0.005 m, and weight (in kilograms) was measured ± 0.1 kg with minimal clothing on. Body mass index, defined as the individual's body mass divided by the square of their height, was calculated. All patients had height and weight and BMI between the 3rd and the 97th percentiles compared with a sex- and age-matched normal population. Body fat percentage (fat %) was estimated from BMI, using Deurenberg's prediction formulas.[7]

Table 1
Baseline Data: Age, Age at Menarche, Time Elapsed Since Menarche and a Summary of Anthropometric Characteristics and Ultrasonographic Findings

	Adolescents with Irregular Cycles		Adolescents with Regular Cycles		Total		*P*
	N = 428		N = 407		N = 835		
	Mean	SD	Mean	SD	Mean	SD	
Age (years)	15.77	2.18	15.58	2.08	15.68	2.14	NS
Time elapsed since menarche (years)	2.94	1.77	2.86	1.76	2.89	1.76	NS
Age at menarche (years)	12.81	1.30	12.70	1.29	12.76	1.29	NS
Height (m)	1.65	0.07	1.66	0.07	1.65	0.07	<.05
Weight (kg)	57.85	11.36	54.92	8.27	56.43	10.08	<.001
BMI (kg/m^2)	21.28	3.83	19.88	2.44	20.61	3.31	<.001
Fat (%)	23.91	4.96	22.10	3.38	23.04	4.36	<.001
Uterus volume (cm^3)	49.54	20.47	48.67	22.72	49.10	21.61	NS
Right ovary volume (cm^3)	8.57	4.11	6.35	2.58	7.42	3.57	<.001
Left ovary volume (cm^3)	8.28	3.82	6.74	4.64	7.48	4.33	<.001
Mean ovarian volume (cm^3)	8.44	3.61	6.52	2.99	7.46	3.45	<0.001

P, Statistical differences between parameters in the group of adolescents with irregular and regular cycles; NS, Not significant.

Statistical Analysis

Statistical analysis was performed with SPSS for Windows software, version 15.0 (SPSS, Chicago, IL). Most of the results are expressed as the mean and SD. The scatter plot was used to compare the volumes of uterus, ovaries and ovarian/uterine ratio, and construction of estimation curves using cubic and linear models was done. The inflection point of the cubic estimated curve was determined as a point at which second derivative changed sign. Pearson's correlation was employed to assess the correlations between considered parameters. A P value of $< .05$ was considered statistically significant. Finally, graphic displays of uterine volume, mean ovarian volume and ovarian/uterine volume ratio versus age were generated.

Results

Data are available for 835 patients. Baseline data including the age at the time of the study, the age at menarche, the time elapsed since menarche and a summary of ultrasonographic findings and anthropometric characteristics are reported in Table 1. There are no differences between RC and IC group of girls regarding the age at the time of the study and the age at menarche. However, the girls with RC are taller, with lower weight, lower BMI, and lower percentage of fat than the girls with IC. Uterine measurements did not differ significantly between the 2 groups. Girls with IC have bigger left, right and mean ovarian volumes. The mean ovarian volume was used for further analysis since the volumes of the right and the left ovary did not differ significantly in each individual subject.

The best curve estimation of uterine volume, according to age for all the patients, was achieved with cubic model. In