A Comparison of Manual and Ultrasound Measurements of Fundal Height

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Background. Uterine fundal height has long been used to assess fetal growth. The common prediction rule states that the distance in centimeters between the pubic symphysis and the top of the fundus equals the gestational age in weeks. The correlation holds best between weeks 18 and 32. This study compares manual and ultrasound measurements of fundal height.

Methods. We compared palpated and ultrasound symphysis–fundal height. We then compared both measurements with gestational age as determined by usual ultrasound measurements. Patients were statistically separated by weight into two groups: normal and obese. We hypothesized that manual measurements of fundal height would be affected by obesity and race.

Results. Ultrasound fundal height and manual fundal height were equivalent ($P \leq .01$, $R^2 = .92$). Regression analysis in normal weight and obese patients showed that both methods have the same predictive power in determining fetal age.

Conclusions. Manual measurements are still a reliable and inexpensive means of evaluating the course of pregnancy. Ultrasound is needed when there is a size-vs-date discrepancy. Ultrasound is also useful for teaching the measurement of fundal height.

Key words. Anthropometry; ultrasonography, prenatal; obesity; symphysis–fundal height measurement.

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The most accurate clinical predictor of gestational age and date of confinement is a reliably reported date of last menstrual period.[1] Research from the past decade suggests that clinical markers, such as last menstrual period and symphysis–fundal height, when consistently monitored and applied, can be as accurate as fetal ultrasound in predicting gestational age.[2] Ultrasound, on the other hand, is not necessarily a reliable indicator of fetal age throughout the entire pregnancy.

Several timely measurements of symphysis–fundal height can yield an accurate estimated gestational age, although measuring techniques can be hindered by extrinsic factors, such as maternal habitus[3] and bladder fullness.[4] Gestational age can be estimated even without a reliable date of last menstrual period, especially when coupled with other clinical markers.[5,6] The accuracy of manual fundal height measurements alone, however, has been questioned. Issues have included the general imprecision of the measurement,[7] variability of measurement techniques,[8] problems of predicting intrauterine growth retardation,[9,10] and differences related to race.[11]

The height of the uterine fundus during pregnancy has been used as a predictor of gestational age for many years. In 1906, McDonald[12] established the distance from the symphysis pubis to the umbilicus to be between 12 and 20 cm. The fundal height between weeks 18 and 32, measured in centimeters from the upper border of the pubic symphysis around the curve of the abdomen and over the top of the uterine fundus, approximates the gestational age in weeks. Manual symphysis–fundal height measurement is actually used to estimate the size or vol-

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ume of the uterus, which in turn yields an estimated gestational age. The measurement becomes less accurate in the final weeks of pregnancy (ie, 36 weeks or later) because of positional shifts of the fetus.[13]

Our research question was whether measuring the symphysis–fundal height manually rather than ultrasonographically would yield different estimates of gestational age. We hypothesized that manual measurements of fundal height would be affected by obesity.

Methods

Study participants were selected from consecutive obstetric patients presenting to our academic family practice residency center for routine fetal ultrasound between January and April 1991. One hundred fifty-nine patients carrying a single fetus between 11 and 42 weeks' gestational age were selected to participate.[14] Measurements for determining fetal age included biparietal diameter, head circumference, abdominal circumference, and femur length. Because the purpose of our study was to compare ultrasonographic and manual measurements, ultrasound was used to locate the true fundal height. This measurement was recorded, along with the fundal height as determined by traditional palpation. A comparison was made between palpated and ultrasound symphysis–fundal height. Patients were statistically subdivided into two groups: those who were within a normal weight range for their height and those who were classified as obese.

Fundal height measurements were obtained for each patient in a uniform manner. Patients were placed on an examination table in a supine position with legs fully extended and arms to the side. The examining physician palpated the uterine fundus, and the measuring tape was placed face down in an effort to eliminate measurement bias.[15] Measurements were made from symphysis to fundus, over the fetal axis, with relaxed abdominal and uterine musculature. The ultrasound fundal height was determined by positioning the transducer at the superior aspect of the uterus so that the top of the fundus was visible on the imaging screen. A finger was placed under the probe until its shadow coincided with the uppermost aspect of the uterus. This point was marked on the abdomen. The distance from the superior aspect of the pubic symphysis to this point represented the true fundal height. Fetal age was then determined by ultrasound using multiple measurements on all subjects. All ultrasound measurements were performed by the authors, using an ATL/ADR 4000 ultrasound scanner with a 3.5-MHz probe.

Fundal height was measured by residents and faculty physicians with obstetric care experience ranging from a few months to more than 15 years. Residents' measurements were verified by faculty. When taking a second measurement, observers were not blinded to either manual or ultrasonographic measurements. We did not test for interrater reliability.

Patients were separated by weight into one of two groups: normal or obese. Because of the variety of definitions for obesity, two methods were used to identify overweight patients. First, any individual who was 20% over ideal body weight (IBW) as defined by the Metropolitan Life Scales[16] was classified as obese. Measurement of body mass index (BMI) was chosen as the second method of classification because it has a stronger statistical relationship with body fat than does relative weight for height.[17] A BMI value of greater than 27.3 kg/cm^2 was used as the indicator of obesity. BMI was determined by the following formula: BMI in kg/cm^2=(weight in pounds)/(height in inches)^2×703.1.[18]

Simple linear regression and analysis of covariance were used to analyze the data. Only 12% of the sample had manual and ultrasound estimates that differed by more than 2 weeks. To measure how well manual fundal height measurements approximated ultrasound measures, the parameters of a simple linear regression of ultrasound on manual fundal height were tested. If the manual measurements were to perfectly match the ultrasound measurements, the regression equation would be ultrasound=0.0+1.0×manual. Therefore, a test in which the regression equation intercept=0 and the slope=1 determines the accuracy of the approximation. Equation parameters were tested for all data combined and for obese and normal groups as determined by the two criteria. An analysis of covariance was used to test whether the regression equations differed between groups according to obesity or race. A significant F test of the interaction between the covariate (manual fundal height) and group (obesity or racial) indicates that group affiliation affects the slope; a significant F test of the group main effect indicates that group membership affects the intercept. Test results with a significance level of .05 or less were considered statistically significant.

Results

Of the 159 patients selected for the study, only 119 had both manual and ultrasound fundal height measurements. Forty patients did not receive both measurements because of differences in medical coverage arrangements. Therefore, all results are based on these 119 patients.

The regression of ultrasound fundal height on manual fundal height was significant ($P<.01$) and had an R^2 value of .92. The results of the tests for slope=1 and intercept=0 were not significant (both P=NS), indicating that there is no significant difference between manual and ultrasound measurements of fundal height. The rela-

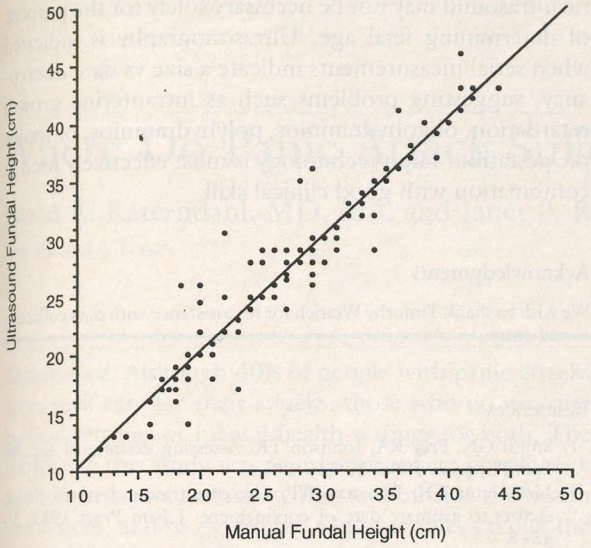

Figure 1. Comparison of manual and ultrasound measurements of fundal height in 119 patients.

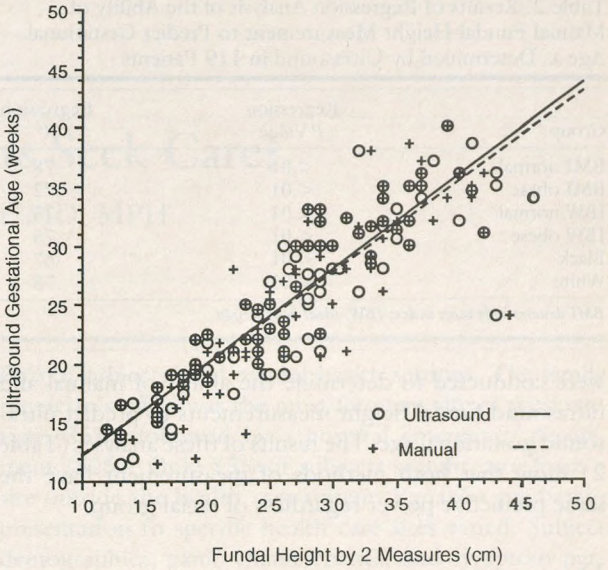

Figure 2. Comparison of manual and ultrasound fundal height measures with gestational age as determined by usual ultrasound measurements in 119 patients.

tion between manual and ultrasound fundal height measurements is shown in Figure 1. Separate regression analyses were computed to determine the ability of ultrasound fundal height and manual fundal height to predict ultrasound gestational age. Both analyses were significant at $P<.01$, and the strength of the predictor relationship as indicated by the R^2 value was slightly higher for ultrasound fundal height (ultrasound $R^2=.79$ and manual $R^2=.75$). Figure 2 shows the predictive ability of ultrasound and manual fundal height measurements for gestational age, as determined by ultrasound.

Data were subsequently analyzed for obese and normal groups using the two methods of defining obesity. The results of the regression analyses and analysis of covariance for the obesity groups show that manual and ultrasound measurements were interchangeable and that obesity had no influence on the relation between ultrasound and manual fundal height measurements for either definition of obesity (Table 1). Separate regression analyses of the obese and normal groups were performed for each definition of obesity to determine the ability of manual and ultrasound fundal height measurements to predict ultrasound gestational age. The results of these analyses show that both methods of measurement have the same predictive power regardless of obesity group or obesity definition (Table 2). We did not consider the possibility that obesity influenced both measurements, resulting in inaccurate predictions of gestational age.

The effect of race on the relation between ultrasound and manual fundal height measurements also was investigated. Because the sample included only three Orientals, only black and white patients were included in the analysis of racial groups. The results of the regression analyses and analysis of covariance for the racial groups show that manual and ultrasound measurements were interchangeable and that race had no influence on the relation between ultrasound and manual fundal height measures (Table 1). Separate regression analyses of the black and white groups

Table 1. Results of Regression Analysis and Analysis of Covariance for the Relation Between Ultrasound and Manual Fundal Height in 119 Patients

Group	No.*	Regression *P* Value	Regression R^2	Slope	Slope *P* Value†	Intercept	Intercept *P* Value‡	Interaction *P* Value
BMI normal	84	<.01	.91	1.02 ± 0.04	.49	−0.41 ± 0.96	NS	NS
BMI obese	29	<.01	.93	0.97 ± 0.05	.55	1.32 ± 1.46	NS	
IBW normal	70	<.01	.89	1.01 ± 0.04	.74	−0.10 ± 1.17	NS	NS
IBW obese	47	<.01	.94	0.99 ± 0.04	.75	0.54 ± 1.09	NS	
Black	27	<.01	.93	0.92 ± 0.05	.15	1.97 ± 1.48	NS	NS
White	87	<.01	.92	1.03 ± 0.03	.38	−0.31 ± 0.91	NS	

**Numbers do not add to 119 because of missing data; †P values for test of slope= 1; ‡P values for test of intercept= 0. BMI denotes body mass index; IBW, ideal body weight; NS, not significant.*

Table 2. Results of Regression Analysis of the Ability of Manual Fundal Height Measurement to Predict Gestational Age as Determined by Ultrasound in 119 Patients

Group	Regression *P* Value	Regression R^2
BMI normal	<.01	.78
BMI obese	<.01	.72
IBW normal	<.01	.75
IBW obese	<.01	.75
Black	<.01	.67
White	<.01	.78

BMI denotes body mass index; IBW, ideal body weight.

were conducted to determine the ability of manual and ultrasound fundal height measurements to predict ultrasound gestational age. The results of these analyses (Table 2) show that both methods of measurement have the same predictive power regardless of racial group.

Discussion

There was excellent agreement between ultrasonographic and manual measurements of fundal height, even in obese patients for whom palpation of the uterine fundus is often difficult. A full bladder can affect fundal height, resulting in erroneous gestational age measurements.[4] In this study, we did not attempt to have each patient void before the fundal height measurements. The increase in fundal height caused by changes in bladder volume did not affect the measurements because manual and ultrasound measurements were performed within 1 to 2 minutes of each other. We assumed that two measurements taken less than 2 minutes apart would not have significant differences, although we did not objectively track these data. No measurement of reproducibility of the manual fundal height was attempted. At least one study, however, has shown very good reproducibility of measurements between examiners of varying obstetric experience.[14]

Physicians with little obstetric experience gained confidence in their own measurement abilities by comparing manual fundal height measurements with those obtained by ultrasound. Actually seeing what they were palpating improved their accuracy. Faculty also demonstrated proper measurement techniques to those whose manual fundal height values differed significantly from the ultrasound results.

Conclusions

In this study, a tape measure and a pair of hands proved equally accurate in assessing gestational age as compared with the technology of ultrasound. Thus, routine obstetric ultrasound may not be necessary solely for the purpose of determining fetal age. Ultrasonography is indicated when serial measurements indicate a size vs date discrepancy, suggesting problems such as intrauterine growth retardation, oligohydramnios, polyhydramnios, or multiple gestation. High technology is most effectively used in combination with good clinical skill.

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