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## Diagnostic accuracy of fundal height and handheld ultrasound-measured abdominal circumference to screen for fetal growth abnormalities

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**OBJECTIVE:** We sought to compare fundal height and handheld ultrasound—measured fetal abdominal circumference (HHAC) for the prediction of fetal growth restriction (FGR) or large for gestational age.

**STUDY DESIGN:** This was a diagnostic accuracy study in non-anomalous singleton pregnancies between 24 and 40 weeks' gestation. Patients underwent HHAC and fundal height measurement prior to formal growth ultrasound. FGR was defined as estimated fetal weight less than 10%, whereas large for gestational age was defined

as estimated fetal weight greater than 90%. Sensitivity and specificity were calculated and compared using methods described elsewhere.

**RESULTS:** There were 251 patients included in this study. HHAC had superior sensitivity and specificity for the detection of FGR (sensitivity, 100% vs 42.86%) and (specificity, 92.62% vs 85.24%). HHAC had higher specificity but lower sensitivity when screening for LGA (specificity, 85.66% vs 66.39%) and (sensitivity, 57.14% vs 71.43%).

**CONCLUSION:** HHAC could prove to be a valuable screening tool in the detection of FGR. Further studies are needed in a larger population.

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### BACKGROUND AND OBJECTIVE

Identification of abnormal fetal growth is a critical component of prenatal care. Failure of antenatal diagnosis can result in increased perinatal morbidity and mortality and affect the long-term health of the neonate. Reliable screening methods to detect fetuses that have potential fetal growth restriction (FGR) and are large for gestational age (LGA) are essential to prevent poor perinatal outcomes.

Numerous studies have shown that fundal height (FH) has poor positive predictive value for identifying abnormally grown fetuses; the increasing

incidence of maternal obesity further confounds this clinical estimation. Current literature supports the theory that measurement of abdominal circumference (AC) in the fetus is the most sensitive single indicator of fetal growth abnormalities.

Our study investigates the ability of portable handheld ultrasound measurements of fetal AC to more accurately screen for fetal growth abnormalities compared with FH measurement. Our group hypothesized that handheld ultrasound measured fetal AC (HHAC) would be a superior screening modality

for detection of abnormal estimated fetal weight (EFW) and birthweight (BW) compared with FH.

### MATERIALS AND METHODS

This was a diagnostic accuracy study as defined by the Standards for Reporting of Diagnostic Accuracy statement comparing the diagnostic accuracy of FH measurements to fetal AC measurements obtained by handheld ultrasound to identify fetal growth abnormalities. The AC obtained from the formal ultrasound (USAC) was included in our investigation of screening modalities.

Patients were eligible for the study if they were at 24–40 weeks' gestational age with a singleton pregnancy and undergoing scheduled ultrasonography to assess fetal growth. Before they underwent formal growth ultrasound by registered diagnostic medical sonographers, an obstetrics and gynecology resident or maternal-fetal medicine specialist

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The authors report no conflict of interest.

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TABLE

**Diagnostic performance of FH, HHAC, USAC, and EFW to predict EFW and BW less than the 10th percentile or greater than the 90th percentile**

Variable	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
<b>EFW less than 10th percentile</b>				
Fundal height (size less than dates)	42.86 (41.68–44.03)	92.62 (92.52–92.73)	14.29 (13.81–14.77)	98.26 (98.21–98.32)
HHAC less than 5th percentile	100 (100–100)	85.25 (85.1–85.39)	16.28 (15.93–16.63)	100 (100–100)
USAC less than 5th percentile	85.71 (84.88–86.54)	92.62 (92.52–92.73)	25 (24.44–25.55)	99.56 (99.53–99.59)
<b>EFW greater than 90th percentile</b>				
Fundal height (size greater than dates)	71.43 (70.36–72.49)	66.39 (66.2–66.58)	5.75 (5.59–5.9)	98.78 (98.72–98.93)
HHAC greater than 95th percentile	57.14 (55.97–58.32)	85.66 (85.52–85.79)	10.2 (9.95–10.56)	98.5 (98.53–98.64)
USAC greater than 95th percentile	100 (100–100)	88.11 (87.99–88.25)	19.44 (19.03–19.86)	100 (100–100)
<b>BW less than 10th percentile</b>				
Fundal height (size less than dates)	37.03 (36.45–37.62)	95.09 (94.99–95.18)	47.62 (46.93–48.3)	92.61 (92.5–92.72)
HHAC less than 5th percentile	74.07 (73.54–74.6)	89.73 (89.61–89.86)	46.51 (46.04–46.99)	96.63 (96.56–96.71)
USAC less than 5th percentile	55.56 (54.96–56.16)	95.98 (95.9–96.06)	62.50 (61.88–63.12)	94.71 (94.62–94.81)
EFW less than 10th percentile	21.43 (20.94)	99.55 (99.52–99.58)	85.71 (84.88–86.54)	90.98 (90.87–91.1)
<b>BW greater than 90th percentile</b>				
Fundal height (size greater than dates)	50 (49.36–50.64)	66.96 (66.77–67.16)	13.79 (13.56–14.03)	92.68 (92.56–92.81)
HHAC greater than 95th percentile	66.67 (66.06–67.27)	89.87 (89.74–89.99)	41.03 (40.53–41.52)	96.23 (96.14–96.31)
USAC greater than 95th percentile	75 (74.45–75.55)	92.07 (91.96–92.18)	50 (49.48–50.52)	97.21 (97.14–97.28)
EFW greater than 90th percentile	25 (24.45–25.55)	99.56 (99.53–99.59)	85.71 (84.89–86.54)	92.62 (92.52–92.73)

Data are in percentages unless otherwise specified.

BW, birthweight; CI, confidence interval; EFW, estimated fetal weight; FH, fundal height; HHAC, handheld ultrasound abdominal circumference; NPV, negative predictive value; PPV, positive predictive value; USAC, ultrasound abdominal circumference.

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measured FH and fetal AC using a portable handheld ultrasound device.

FH was measured from the pubis symphysis to the top of the uterine fundus with a measuring tape in centimeters. Size greater than dates was recorded if the measurement was 3 cm or greater above the patient's gestational age. Similarly, size less than dates was recorded if the measurement was 3 cm or less below the patient's gestational age.

A positive screen for FGR was recorded as HHAC less than the fifth percentile. A positive screen for LGA was an HHAC greater than the 95th percentile. For the current study, FGR was defined as EFW less than the 90th percentile; LGA, as EFW greater than the 90th percentile because macrosomia cannot be diagnosed until a fetus reaches greater than 4000 g. Therefore, LGA will refer to both EFW greater than the 90th

percentile and BW greater than the 90th percentile.

Small for gestational age (SGA) at the time of delivery was defined as a BW less than the 10th percentile and LGA as a BW greater than the 90th percentile. Sensitivity and specificity of the screening tests were calculated with EFW and BW as the gold standard to which they were compared.

## RESULTS

A total of 251 patients were enrolled in our study from April 2013 through October 2013. A highly significant correlation between HHAC and AC was determined at the time of a formal ultrasound ( $R = 0.939$ ;  $P < .001$ ), leading us to accept that the AC measurements made by the clinicians using the handheld ultrasound device were overall comparable with

measurements performed by the registered diagnostic medical sonographer-certified ultrasonographers.

In our study population, 7 fetuses (2.79%) met criteria for FGR, defined as EFW less than the 10th percentile on the scheduled growth scan. Similarly, 7 fetuses (2.79%) met criteria for LGA, measuring greater than the 90th percentile at the time of scheduled ultrasound screening. However, once BWs were collected and percentiles calculated using gestational age at delivery and sex of the infant by the method of Olsen et al, we found that 27 infants (10.76%) were considered SGA, defined as a BW below the 10th percentile. On the other hand, 24 infants (9.56%) were found to be LGA (BW greater than the 90th percentile).

When we screened for EFW less than the 10th percentile, HHAC had the

highest sensitivity when compared with USAC and FH (100% vs 84.71% vs 42.86%) but lower specificity (85.25% vs 92.62% vs 92.62%). When screening for EFW greater than the 90th percentile, HHAC had the lowest sensitivity when compared with USAC and FH (57.14% vs 100% vs 71.43%) and comparable specificity with USAC (85.66% vs 88.11% vs 66.39%) (Table).

When screening for SGA (BW less than the 10th percentile), we found that HHAC had superior sensitivity compared with FH, USAC, and EFW (74.07% vs 37.03% vs 55.56% vs 21.43%) but lower specificity (89.73% vs 95.09% vs 95.98% vs 99.55%). When screening for LGA (BW greater than the 90th percentile), USAC had the highest sensitivity compared with FH, HHAC, and EFW (75% vs 50% vs 66.67% vs 25%), whereas EFW had highest specificity compared with FH, HHAC, and

USAC (99.56% vs 66.96% vs 89.87% vs 92.07%).

#### COMMENT

This study illustrates that HHAC has the potential to be a valuable screening tool for FGR. This is the first study investigating the use of a handheld ultrasound to screen for fetal growth abnormalities using a simple AC measurement.

Previous studies have compared FH with traditional measurement of fetal AC in term pregnancies to predict high and low BWs with the conclusion that fetal AC measurement by ultrasound is superior to clinical examination. Our study differs in that we looked at a variety of gestational ages and the ability of several different screening modalities to detect SGA and LGA at the time of delivery. We were able to validate the clinician-performed HHAC measurements with a

strong correlation between the AC we obtained with our portable device and the measurements obtained during the scheduled ultrasound. These data were able to be reproduced regardless of maternal BMI or gestational age.

Further studies in a larger, low-risk population could provide valuable insight into the cost-saving benefits and feasibility of HHAC as a routine prenatal evaluation instead of fundal height measurement.

#### CLINICAL IMPLICATIONS

- Use of a handheld ultrasound could prove to be a valuable and cost-effective screening modality for fetal growth abnormalities at the bedside.
- Future trials should focus on integration of this screening modality in a low-risk population. ■

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