OBSTETRICS

Fractional fetal thigh volume in the prediction of normal and abnormal fetal growth during the third trimester of pregnancy

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BACKGROUND: Currently, 2-dimensional ultrasound estimation of fetal size rather than fetal growth is used to define fetal growth restriction, but single estimates in late pregnancy lack sensitivity and may identify small for gestational age rather than growth restriction. Single or longitudinal measures of 3-dimensional fractional thigh volume may address this problem.

OBJECTIVE: We sought to derive normal values for 3-dimensional fractional thigh volume in the third trimester, determine if fractional thigh volume is superior to 2-dimensional ultrasound biometry alone for detecting fetal growth restriction, and determine whether individualized growth assessment parameters have the potential to identify fetal growth restriction remote from term delivery.

STUDY DESIGN: This was a longitudinal prospective cohort study of 115 unselected pregnancies in a tertiary referral unit (St Mary's Hospital, Manchester, United Kingdom). Standard 2-dimensional ultrasound biometry measurements were obtained, along with fractional thigh volume measurements (based on 50% of the femoral diaphysis length). Measurements were used to calculate estimated fetal weight (Hadlock). Individualized growth assessment parameters and percentage deviations in longitudinally measured biometrics were determined using a Web-based system (iGAP; http://iGAP.research.bcm.edu). Small for gestational age was defined <10th and fetal growth restriction <3rd customized birthweight centile. Logistic regression was used to compare estimated fetal weight (Hadlock), estimated fetal weight (biparietal diameter—abdominal circumference—fractional thigh volume), fractional thigh volume, and abdominal circumference for the prediction of small for gestational age or fetal growth restriction at birth. Screening performance was assessed using area under the receiver operating characteristic curve.

RESULTS: There was a better correlation between fractional thigh volume and estimated fetal weight ((biparietal diameter—abdominal circumference—fractional thigh volume) obtained at 34-36 weeks with birthweight than between 2-dimensional biometry measures such as abdominal circumference and estimated fetal weight (Hadlock). There was also a modest improvement in the detection of both small for gestational age and fetal growth restriction using fractional thigh volume—derived measures compared to standard 2-dimensional measurements (area under receiver operating characteristic curve, 0.86; 95% confidence interval, 0.79—0.94, and area under receiver operating characteristic curve, 0.92; 95% confidence interval, 0.85—0.99, respectively).

CONCLUSION: Fractional thigh volume measurements offer some improvement over 2-dimensional biometry for the detection of late-onset fetal growth restriction at 34-36 weeks.

Key words: estimated fetal weight, fetal growth restriction, fractional thigh volume, small for gestational age, 3-dimensional ultrasound

Introduction

The detection of fetal growth restriction (FGR) antenatally remains a challenge,[1] as undetected abnormalities in fetal growth remain one of the strongest risk factors for stillbirth and term perinatal death.[2-6] This problem is particularly important in late-onset FGR, which is usually defined by ultrasound estimation of fetal size; however, single estimates of fetal size have a low sensitivity for the detection of FGR.[7] It is also difficult to distinguish between a fetus that is constitutionally small for gestational age (SGA) and one that has pathological FGR. This is important in clinical practice as it is recognized that growth-restricted fetuses are most at risk for adverse perinatal outcomes such as admission to neonatal intensive care unit, low 5-minute Apgar scores, neurological injury, and even stillbirth or early neonatal death.[8,9] Many different methods have been described to differentiate between healthy and pathologically small fetuses including the use of customized growth charts,[10] analysis of placental and fetal Doppler blood flow,[11] analysis of fetal growth velocity,[12] and the use of placentally derived biomarkers.[13] However, these methods have been evaluated mainly in the context of early-onset FGR <34 weeks.[14] Doppler ultrasound of umbilical artery flow, which is the mainstay of FGR diagnosis and management in early-onset FGR, is of limited use in identifying term FGR, as this will often be normal.[14] Screening using the cerebroplacental ratio and uterine artery pulsatility index at 35-37 weeks has demonstrated potential, but this requires further validation.[15-19]

Despite the limitations of fetal size—based assessment, investigators have continued to examine the use of estimated fetal weight (EFW) calculated using 2-dimensional (2D) ultrasound measurements such as that described by Hadlock et al.[20] This screening is based on estimations of fetal size at a single point rather than growth velocity, so that fetuses >10th centile, but not achieving their growth potential, will not be identified as at risk of FGR. Unsurprisingly, detection of SGA is better the nearer the ultrasound scan is performed to delivery

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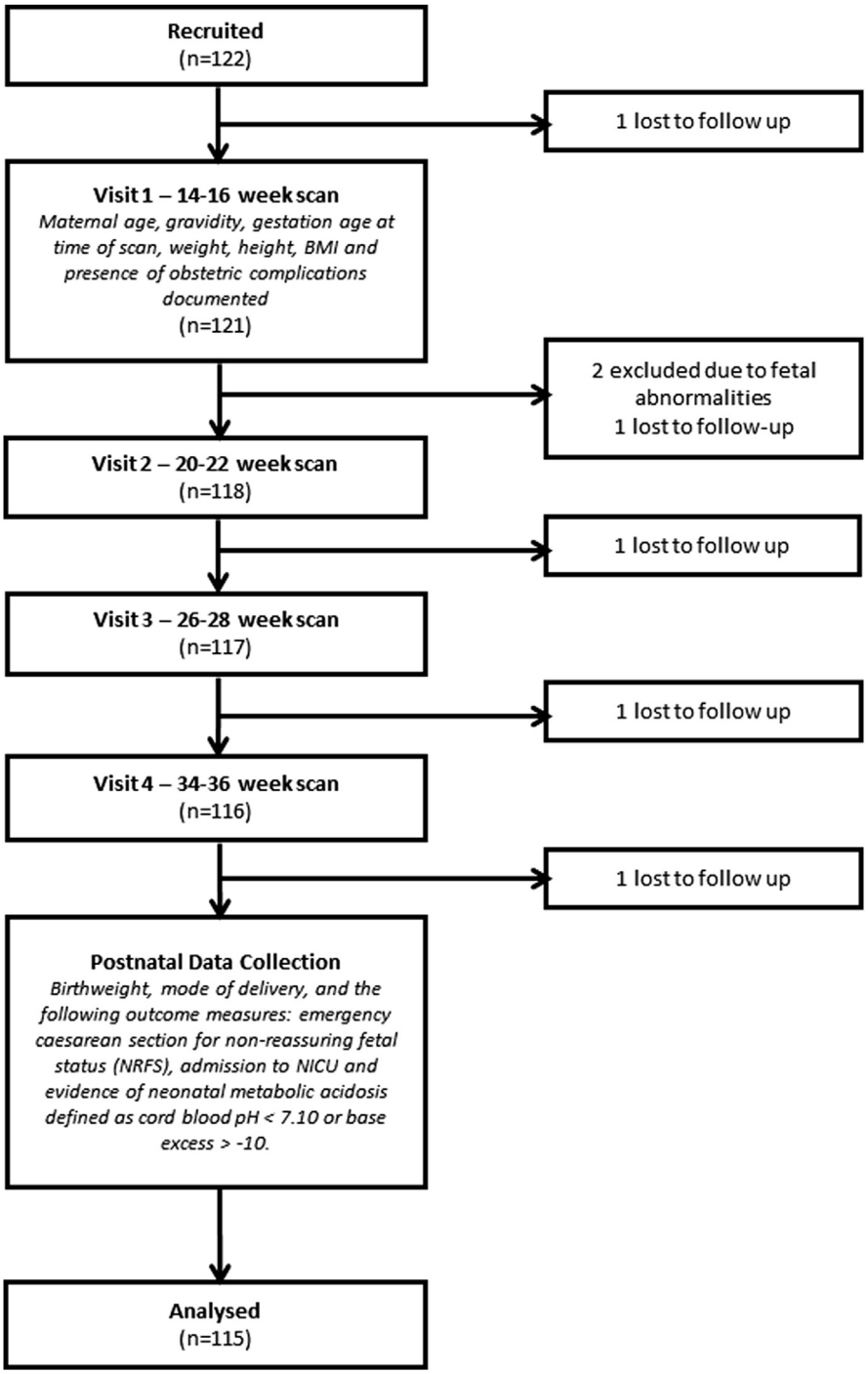
FIGURE 1
Study design and participant recruitment and follow-up flow diagram



Participant flow diagram.

BMI, body mass index; *NICU*, neonatal intensive care unit.

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(70-75% at 35-37 weeks and 50-60% at 30-34 weeks for the same 10% false-positive rate).[21] These single estimates of fetal size are also hampered by the lack of adjustment for differences in individual growth potential and therefore a method designed to adjust for individual growth was developed: individualized growth assessment (IGA).[12] In IGA, second-trimester growth velocity data are used to determine Rossavik growth models that predict individual third-trimester growth trajectories. Three-dimensional (3D) sonography may allow more accurate assessment of fetal weight and improved differentiation between normal and pathological growth because it includes soft-tissue volume.[22] Fetal thigh volume and the derived fractional thigh volume (TVol) were reported to be the most accurate and reproducible method to estimate birthweight.[23-26] Second-trimester TVol measurements can also be used to generate Rossavik models for predicting TVol and EFW growth trajectories during the third trimester.[27,28]

The aim of this study was to create reference centiles for TVol measurements and to examine whether 3D measurements of fetal soft tissues can detect pathological deviations in fetal growth more accurately than conventional 2D measurements.

Materials and Methods

Study design

This was a longitudinal prospective study of fetal biometry using 2D and 3D ultrasound in 1 tertiary referral unit (St Mary's Hospital, Manchester, United Kingdom). From November 2013 through July 2015, women with healthy uncomplicated singleton pregnancies were invited to participate. Exclusion criteria were: fetuses subsequently shown to have a major congenital abnormality, multiple pregnancies, and maternal medical conditions known to affect fetal growth such as maternal diabetes, renal disease, and chronic hypertension. Ultrasound scans were performed for research purposes and were not part of routine antenatal care, and did not include clinically indicated examinations. Scan results were available to view in the clinical records.

Participant recruitment

The study was approved by the Greater Manchester East National Research Ethics Committee in 2010 (Ref 10/H1013/9) and all participants were enrolled under signed informed consent.

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