Evaluation of role of femur length / mid thigh circumference ratio in differentiation between small for gestational age but healthy fetuses and intrauterine growth restricted fetuses

Thesis
Submitted to the Faculty of Medicine,
Ain Shams University

In Partial Fulfillment for the Degree of
MASTER OF OBSTETRICS AND GYNECOLOGY
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2017

ACKNOWLEDGEMENT

I would like to express my deepest appreciation, respect and thanks to Prof. Dr. Ahmed Mohammed Ibrahim, Professor of Obstetrics and Gynecology, Faculty of Medicine, Ain Shams University, for his kind supervision, valuable advice, faithful support, giving me the privilege and honor of working under his supervision and for cleaning obstacles during this study.

I wish to express my high appreciation and great thanks to Ass. Prof. Dr. Alaa Sayed Hassanin, Assistant Professor of Obstetrics and Gynecology, Faculty of Medicine, Ain Shams University, who helped me to a great extent, for her kind supervision and energetic help in following the details of this work.

This work could not have been completed without the great cooperation and assistance of the personnel of the ultrasound unit, especially Dr. Engy Sami Abdel-Gawad ultrasound specialist.

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List of abbreviations

2-D: two dimensions
2D US: two dimensions ultrasound
2SD: double standard deviation
AC: abdominal circumference
AFI: amniotic fluid index
AFV: amniotic fluid volume
ATD: abdominal transverse diameter
AUC: area under the ROC curve
BMI: body mass index
BPD: biparietal diameter
BW: birth weight
CI: confidence interval
CS: cesarean section
DBP: diastolic blood pressure
DM: diabetes mellitus
EFBW: estimated fetal body weight
EFW: estimation of fetal weight
FBW: fetal birth weight
FL: femur length
FL/AC: femur length /abdominal circumference
FL/MTC: femur length / mid thigh circumference
FL/TC: femur length /thigh circumference
FW: fetal weight
HC: head circumference
HC/AC: head /abdominal circumference
g: grams
GA: gestational age
GHV: growth hormone variant
gm: grams
IGA: individualized growth assessment
IGF-I: insulin growth factor 1
IUFD: intrauterine fetal death
IUGR: intrauterine growth restriction
LBW: low birth weight
LMP: last menstrual period
MCA: middle cerebral artery
MCA PSV: middle cerebral artery peak systolic velocity
MCA RI: middle cerebral artery resistance index
MTC: mid thigh circumference
NPV: negative predictive value
PG: primigravida
PGH: placental growth hormone

PI: ponderal index
PI: pulsatility index
PPV: positive predictive value
ROC curve: receiver operating characteristic curve
SBP: systolic blood pressure
SCT/FL: subcutaneous tissue width / femur length
SE: standard error
SGA: small for gestational age
TC: thigh circumference
UA: umbilical artery
UA RI: umbilical artery resistance index

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INTRODUCTION

Small for gestational age (SGA) infants are often designated as suffering from intrauterine growth restriction (IUGR). It is estimated that from 3 to 10 percent of infants are growth restricted ***(Leveno et al., 2013).***

Small for gestational age infants are generally considered to be those whose weight are below 10^{th} percentile for their gestational age. Not all infants with birth weights less than 10^{th} percentile, however, are pathologically growth restricted; some are small simply because of constitutional factors. Indeed, 25 to 60 percent of infants conventionally diagnosed to be SGA are in fact, appropriately grown when determinants of birth weight such as maternal ethnic group, parity, weight, and height are considered (***Leveno et al., 2013).***

A definition of SGA that is based upon birth weight below 5^{th} percentile has also been proposed. Normal fetal grow standards are sometimes based on mean values with normal limits defined by ±2 standard deviations. This definition would limit SGA infants to 3 percent of births instead of 10 percent. In fact, most poor outcomes are in those infant with birth weights below the 3^{rd} percentile. Most recently, individual fetal growth potential has been proposed in place of a population – based cutoff. In this model, a fetus that is less than its individual optimal size at a given gestational age would be considered growth restricted (***Leveno et al., 2013).***

In a study made about outcome of fetuses with diagnosis of isolated short femur in the second half of pregnancy, SGA, IUGR, and abnormal umbilical artery Doppler (AUD) were more frequent in the fetuses with short femur. According to receiver-operating characteristic ROC analysis,

femur length (FL) measurement behaved as a good diagnostic test for SGA and IUGR ***(Morales-Roselló and Llorens, 2012).***

In another study made to assess the association between isolated short fetal femur and intrauterine growth restriction, it was found that an isolated short femur is associated with intrauterine growth restriction and adverse pregnancy outcome, but in non-isolated cases was found to be associated with chromosomal disorders, skeletal abnormalities and multiple abnormalities ***(Vermeer and Bekker, 2013).***

In a study about using anterior-posterior thigh diameter (APTD) measured by two-dimensional sonography as an indicator of fetal age at 18 to 28 weeks gestation, significant correlation was found between (APTD) and fetal age from simple line regression analysis, with >99.9% confidence intervals at each week from 18 to 28 weeks gestation. There was a correlation of 1 mm APTD per 1 week of fetal age, which indicates that APTD is a reliable and valid method for assessing fetal age in a normal pregnancy and may be particularly useful when other parameters are unable accurately to predict fetal age. An accurate linear measurement of multiple fetal parameters allows a more complete profile of fetal growth and estimated date of delivery (EDD). APTD may also be useful in identifying fetal growth problems ***(Al-Kubaisi, 2006).***

In a prospective study about prediction of fetal birth weight from measurement of fetal thigh circumference by two-dimensional ultrasound, a two-dimensional ultrasound scan was performed between 38 and 40 weeks gestation, which measured the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and thigh circumference (TC) at the level of midthigh, and incorporated them to estimate fetal weight. The results of this study show that the fetal

thigh circumference, if incorporated with other standard biometric parameters in estimating fetal weight by ultrasound, improves the predictability of birth weight estimation, and can predict intra-uterine growth restriction ***(Sanyal et al. 2012).***

In a study about role of fetal thigh circumference in estimation of birth weight by ultrasound, it was found that incorporating fetal thigh circumference measurements along with biparietal diameter, femur length and abdominal circumference, significantly improved the accuracy of birth weight estimations by ultrasound. There was a good correlation between ultrasound measurements and actual postnatal measurements of thigh circumference. (***Dahiya et al. 2010)***

In a study about longitudinal measurement of fetal thigh soft tissue parameters and its role in the prediction of birth weight (BW), it was found that the fetal abdominal subcutaneous tissue (FAST) and thigh muscle and fat show an increase with gestation. At 28 weeks gestation, the abdominal circumference, thigh fat, FAST, and EFW percentile were found to be significant predictors of BW. A combination of EFW percentile and thigh fat were found to be the optimal multivariate model at 28 weeks for predicting BW. At 37 weeks, BW prediction using EFW percentile, FAST, and thigh fat was the most accurate. The results revealed acceptable reproducibility for fetal thigh muscle and fat. The study provides reference ranges for thigh fat and muscle at 28 and 37 weeks gestation. The inclusion of fetal thigh fat in the algorithm improves the predictive power for birth weight. This information is important to explore the role of fetal thigh in the detection of aberrant growth. ***(O'Connor et al. 2013)***

In a study about role of fetal thigh circumference (TC) in estimation of birth weight by ultrasound, it was found that the results of this study

clearly indicate that fetal TC measurements add to the accuracy of birth weight estimation in obstetric practice. Measurements of TC provide a potentially straight forward method for assessing the deposition of muscle and fat in the growing fetus. This parameter is preferred over diameter measurements as it is less sensitive to changes in shape. Anatomical studies have proved that the correct plane for TC is located at the middle of the thigh. Ultrasound measurement of fetal thigh circumference is uniformly reproducible within 4% error and is comparable to other fetal parameters in variability. Formulas incorporating TC measurements may be proven most useful in predicting fetal weight when growth abnormalities are present. Fetal growth aberrations are associated with changes in the soft tissue mass which is decreased in IUGR. Pediatric experience has shown that TC is one of the parameters that reflect soft tissues mass. Recently imaging fetal limb volume by 3D ultrasound has proved that fetal thigh measurements facilitate accurate prediction of birth weight. Thus it can be inferred that TC measurements using ultrasound add to obstetrician's ability to predict intrauterine growth abnormalities. ***(Hebbar and Varalakshmi, 2007)***

Aim of the study

To evaluate femur length/mid thigh circumference ratio in intrauterine growth restricted fetuses in comparison to small for gestational age but healthy fetuses.

Research question:

In pregnant women, can femur length /mid thigh circumference ratio differentiate between IUGR fetuses and SGA but healthy fetuses?

Hypothesis:

In pregnant women it is hypothesized that using femur length / mid thigh circumference ratio can differentiate between small for gestational age but healthy fetuses and intrauterine growth restricted fetuses.

Methodology

Detailed Description:

Technical design:

Study design: Observational Case-Control study.

Study site: This study will be conducted at the department of Obstetrics and Gynecology, Faculty of Medicine, Ain Shams University recruiting pregnant women selected from the attendees of antenatal clinic, emergency department and from inpatient wards of Ain Shams University Maternity Hospital.

Duration: from June 2015 till May 2016.

Sample size: 89 participants.

This study will include 89 pregnant women. These cases will be divided into 2 groups:

1. Small for gestational age fetuses group: will include 55 pregnant females all in third trimester followed by serial ultrasound over 2weeks and show normal growth during this follow up. On first ultrasound the estimated fetal weight should be below the 10^{th} percentile according to that of gestational age, on the second ultrasound the fetal weight will be increased by the same rate and the growth curve will be parallel to the normal growth curve, e.g., if during first ultrasound the fetal weight was at the 5^{th} percentile of that gestational age, on the second ultrasound the fetal weight will be at the 5^{th} percentile of the new gestational age
2. IUGR fetuses Group: will include 34 pregnant females all in third trimester followed by serial ultrasound for 2 weeks and showing retarded growth, and show much retarded growth during follow up. On the first ultrasound the estimated fetal weight should be below the 2SD of the mean weight of the same gestational age, and the