INTRODUCTION

Accurate estimation of fetal weight is of great importance in the management of labour and delivery. During the last decade, estimated fetal weight has been incorporated into the standard routine antepartm evaluation of high risk pregnancies and deliveries such as, diabetic pregnancy, preterm delivery, vaginal birth after a previous caesarean section and intrapartum management of fetuses presenting by the breech ***(Prechapanich et al., 2004).***

High rate of perinatal mortality is still a major cause for concern in some of the developing countries. A large portion of this problem is related to birth weight which remains the single most important parameter that determines neonatal survival and infants who deviate from physiologic norms of weight for gestational age have increased perinatal morbidity and mortality ***(Melamed et al., 2009).***

For example, management of preterm delivery depends wholly or in part on the estimation of expected birth weight which helps in perinatal counseling on likelihood of survival, the intervention undertaken to postpone the delivery, optimal route of delivery, or the level of hospital where delivery should occur ***(Akinola et al., 2007)***.

It is estimated that 16% of live-born infants have low birth weight condition associated with high perinatal morbidity and mortality. At the current time, there is a great controversy over how the Obstetrics management should be when the delivery of a low birth weight infant is imminent ***(Iffy et al., 2008).***

Shoulder dystocia occurs in 0.2% of all deliveries but its incidence rises to 5% in birth weight of 4000-4500gm and up to 30% in babies larger than 4500gm. Moreover, 50% of the cases of shoulder dystocia occur in babies weighting <4000gm. In 10% of reported cases of shoulder dystocia, brachial plexus injury is found but about 90% of those are temporary ***(Weiner et al., 2002)***.

Tactile assessment of fetal size is the oldest technique for assessing fetal weight and is also referred to as clinical palpation or Leopold maneuvers. It involves manual assessment of fetal size by the obstetricians. Worldwide, this method is used extensively because it is both convenient and virtually costless; however, it is a subjective method associated with notable predictive errors ***(Horta et al., 1997)***.

Since the introduction of ultrasound into obstetrics in the late 1950s, it has played an increasingly important role in the characterization normal fetal growth and the detection of fetal growth abnormalities. Fetal growth assessment is very important to clinicians as decrease or excess in fetal growth is associated with increased mortality and morbidity during the perinatal period ***(Bernstein et al., 2000)***.

Most of formulas used for estimation of fetal weight EFW use the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), or femur length (FL) measurements as follows:

- Camppbell et al., formula used the FL and AC.
- Shepard et al., used BPD and FL.
- Hadlock et al., used FL, AC, and BPD.
- Roberts et al., used FL, AC, BPD, and HC.
- Sabbagha et al., used HC, AC, and FL.

(Alfonso and Portman, 1995)

It have been suggested that formulae based on the Biparietal diameter (BPD) and Abdominal circumference (AC) predict accurately the fetal weight within 10% of the actual weight and the addition of femur length (FL) seems to improve the accuracy of fetal weight prediction ***(Isobe, 2004).***

Sonographic estimation of birth weight is less accurate in infants less than 2500 gm or greater than 4000 gm ***(Gallivant et al., 1993).***

The majority of studies on prediction of macrosomia are based on sonographic measurements employed as either single parameters (such as abdominal circumference or subcutaneous tissue thickness) or combinations of measures to estimate fetal weight. The different sonographic methods do not seem to differ substantially in terms of power to predict macrosomia ***(O'Reilly-Green et al., 2000).***

The use of multiple parameters has been shown to decrease errors in fetal weight estimation ***(Benson and Doubilet, 1986).***

Thigh volume as a new soft tissue parameter for fetal growth evaluation is introduced as a new parameter that may allow earlier detection and improved monitoring of fetal soft tissue abnormalities such as Intra-uterine growth restriction (IUGR) ***(Lee, 2004).***

Fetal growth retardation FGR results in a decrease in both adipose tissue and muscle mass. Measurement of fetal soft tissue is probably predictive of FGR; however, there are inadequate data for defining the best site for measurement or the sensitivity and specificity of this parameter. Measurement of the fetal thigh circumference incorporates the contributions of both adipose and muscle. In one study, a thigh circumference measuring 2 SD below the mean had a sensitivity of 78 percent and a positive predictive value of 85 percent in the prediction of FGR ***(Mitkowska et al., 2003).***

AC alone can be used for predicting weight in normally growing fetuses at term and in low-risk populations; however, this method has limitations when used in preterm or growth restricted fetuses ***(David et al., 1996).***

Therefore, additional sonographic variables have been incorporated into models for predicting fetal growth abnormalities. Fetal weight estimation has become one of the most common methods of identifying the growth-restricted fetus since pediatricians use birth weight as their primary variable for defining growth restriction in the infant ***(David et al., 1996).***

Placental thickness is closely related to fetal wellbeing and may be a key factor in perinatal outcome. Large placentae are associated with hemolytic disease of newborn, maternal diabetes mellitus, severe anemia and intrauterine fetal infections ***(Spirt and Gordon, 1996).***

Small placentas are associated with preeclampsia, chromosomal abnormalities, severe maternal diabetes mellitus, chronic fetal infections and intrauterine growth restriction ***(Sadler, 2004).***

Obstetric ultrasonography offers the tools to estimate fetal weight and assess placental size. A study reported that ultrasonographic measurement of placental diameter and thickness is of prognostic value in identifying the subsequent occurrence of fetal growth restriction ***(Habib, 2002).***

In a previous study ***(Alghannam et al., 2012)*** a new formula was deduced that incorporated placental thickness as an added parameter to the Hadlock's 2 formula for prediction of birth weight.

The new formula was postulated using linear regression for the correction of estimated birth weight with the addition of placental thickness to the Hadlock's 2 formula which resulted in an error-correcting modification on the EFW using Hadlock's formula as follows:

(EFW in grams) = (EFW using Hadlock's 2 formula x 0.789) + (186.193 x Placental Thickness in centimeters)

This formula lowered the difference between the ultrasound estimated fetal weight and the actual birth weight.

AIM OF THE WORK

Objective

The current study aims to verify the previously postulated formula that encorporates placental thickness in the estimation of birth weight.

Study Question

In term pregnancy, does the addition of placental thickness as a sonographic parameter improves the accuracy of the Hadlock's 2 formula in prediction of birth weight?

Study Hypothesis

The addition of placental thickness as a sonographic parameter improves the accuracy of the Hadlock's 2 formula in prediction of birth weight.

NORMAL FETAL GROWTH AND WEIGHT

The average term infant at birth weights about 3000 to 3600 gm. During the second half of pregnancy, the fetal weight increases in a linear manner with time until about the 37th week of gestation and then the rate slows variably ***(Farah et al., 2009)***.

Since the fetus always grows more rapidly in the weight than does the placenta, a time comes when the support is no longer adequate for unrestrained growth which is at about 37 weeks or later. At that time, the birth weight curve departs from the straight course ***(Bernstein et al., 2000).***

Many percentile curves were constructed in which the birth weight was plotted against maturity. For example, for any given maturity, 90% of the babies weighed an amount equal to or less than the Figure stated on the 90th percentile curve ***(Gardosi, 1996)***.

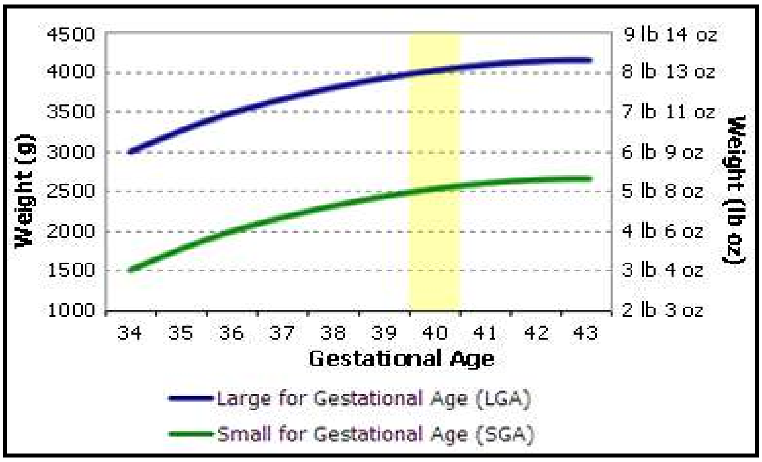

Figure (1): Normal fetal growth and weight ***(Gardosi, 1996).***

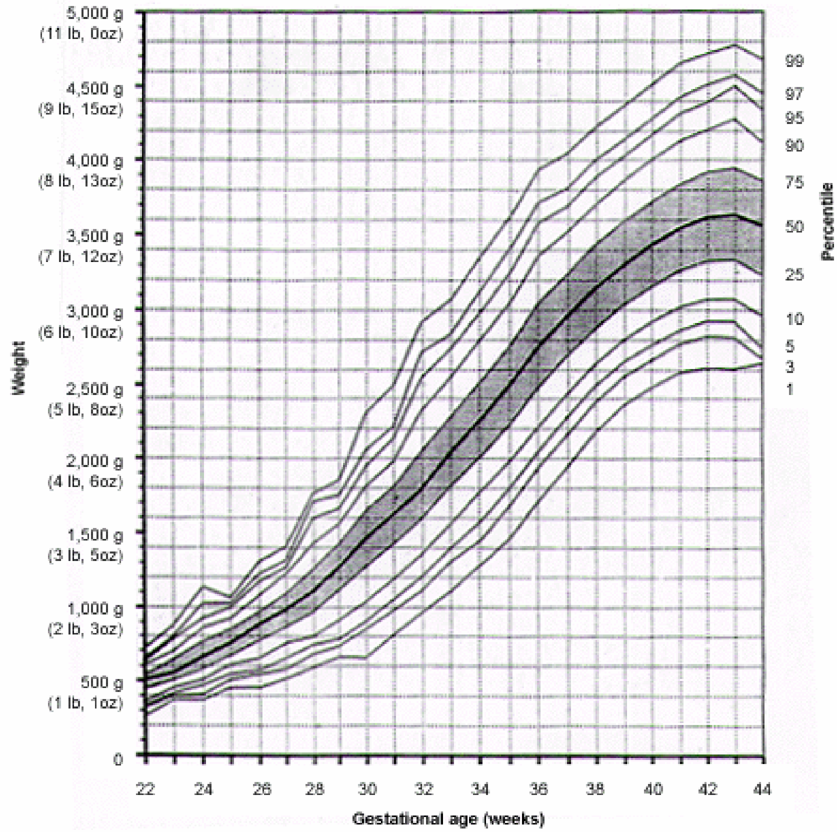

Figure (2): Normal fetal growth curves and percentiles *(Gruenwald et al., 1967).*

Factors affecting fetal growth and weight:

1. Maternal weight and height:

The maternal weight rather than height more importantly affects birth weight. There is an increase of 15-24gm in birth weight for every kilogram maternal weight gained during pregnancy. While for every centimeter of maternal height above the base line value (160cm), there is an increase of about 16 gm in birth weight ***(Thame et al., 2004).***

Maternal anthropometric parameters, such as pre-gestational body size indices and gestational weight gain have been shown to be independent determinants of the size of the offspring ***(Jensen et al., 2003)***.

2. Paternal weight and height:

Also, there is an increase of about 9 gm in birth weight for every centimeter of father's height above the base line value ***(Bernstein et al., 2010)***.

3. Maternal age and parity:

Apart from parity, maternal age has a little influence on birth weight. The second and subsequent babies grow faster than first babies, possibly due to enhanced efficiency of uterine circulation ***(Claas et al., 2011)***.

4. Fetal sex:

The birth weight of both sexes are identical at 32-33 weeks of gestation and then gradually diverge, males being about 105 gm heavier than females at term.The cause may be antigenic difference between the male fetus and his mother or it may be the sex hormone difference ***(Ounsted et al., 1970)***.

5. Race:

True racial difference in birth weight occurs; showed that the mean birth weight can differ by as much as 700gm between different races. In a multiethnic study reported that there is significant differences for ultrasound measurement of the fetal head estimated fetal weight between Belgian pregnant woman and Moroccan and Turkish pregnant woman ***(Jacquemyn et al., 2002)***.

6. Socioeconomic and nutritional status:

The lower mean birth weight observed among the poor is ascribed to their deficient nutritional intake. However the consideration that inadequate diet depresses birth weight is not as simple as many other factors accompany malnutrition ***(Nancy et al., 2007)***.

7. Maternal smoking and alcoholism:

Cigarette smoking leads to an average reduction in birth weight of approximately 200 gm that is independent for other factors influencing birth weight. This effect is dose related to the number of cigarettes smoked. Alcohol intake during pregnancy causes deleterious fetal effects. Intrauterine growth retardation is the most consistent manifestation ***(Langly et al., 2007)***.

8. Duration of pregnancy:

The longer the pregnancy continues beyond term, the greater the likelihood of the fetus appearing undernourished and chronically distressed. The fetus does actually lose weight. Even so, the majority of fetuses probably continue to gain weight if the placenta function remains uncomplicated ***(Pritchard et al., 1980)***.

9. Placental size, anomalies and function:

There is a direct relationship between placenta and fetal weights that becomes evident during the first trimester and less evident onwards; due to the rapid rate of growth of the fetus that exceeds the placental growth rate. The placental weight is not an indication of its function. The association of large placenta with large fetuses may be only a reflection of the somatic growth promoting influences the same for the small placenta associated with small fetus ***(Peter, 2009)***.

It was found that the velamentous and battledore insertions of the umbilical cord were associated with an increased incidence of small for date fetuses and that the severe varieties of placental previa are associated with small neonates ***(Varma et al.,1993)***.

The placenta influences fetal growth through its functional size, capacity to transport oxygen and nutrients, and its own metabolism. Placental growth is crucial to fetal growth. This is supported by the fact that, throughout gestation, placental growth closely parallels fetal growth. In addition, it has been demonstrated recently that placental volume measured at 14 weeks was directly related to fetal anthropometric measurements at 35 weeks ***(Sacks, 2004)***.

10. Genetic influences:

Elements from both the maternal and the paternal genome are required for normal fetal growth and development.

Recent data have demonstrated that, for certain genes, only one allele is functional. This is referred to as genetic imprinting, an epigenetic mechanism by which one of the two alleles of a gene is expressed according to its parental origin. The allele that is silenced is called imprinted that most maternally imprinted genes act as growth suppressors (e.g., HI 9, p57), whereas paternal ones act as growth promoters e.g., insulin-like growth factor 2, (IGF-2) ***(Devriendt, 2004).***

It has been postulated that imprinting occurs because of conflicts between the maternal and paternal genome and nutrient transfer to the fetus from the mother. Thus, paternally expressed genes result in fetal growth promotion at the expense of the mother, whereas genes that are maternally expressed would have the opposite effect ***(Devriendt, 2004).***

It has been shown that biallelic expression of IGF-2 leads to overgrowth of the fetus, which is recognized clinically as Beckwith-Wiedemann syndrome, characterized by large birth weight, organomegaly, macroglossia, and neonatal hypoglycemia. Deletion of the paternal IGF-2 allele has been shown to cause fetal growth restriction ***(Constancia et al., 2002)***.

Importance of Fetal Weight Estimation

Accurate estimation of fetal weight is of great importance in the management of labour and delivery. During the last decade, estimated fetal weight has been incorporated into the standard routine antepartum evaluation of high risk pregnancies and deliveries such as, diabetic pregnancy, preterm delivery, vaginal birth after a previous caesarean section and intrapartum management of fetuses presenting by the breech ***(Prechapanich et al., 2004).***

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For example, management of preterm delivery depends wholly or in part on the estimation of expected birth weight which helps in perinatal counseling on likelihood of survival, the intervention undertaken to postpone the delivery, optimal route of delivery, or the level of hospital where delivery should occur ***(Akinola et al., 2007)***.

It is estimated that 16% of live-born infants have low birth weight, a condition associated with high perinatal morbidity and mortality. At the current time, there is a great controversy over how the Obstetrics management should be when the delivery of a low birth weight infant is imminent ***(Iffy et al., 2008).***

Currently, neonatal intensive care units report improvement in neonatal survival rates and long term prognosis for infants weighting between 750 and 1500gm, a fact which is forcing obstetricians to make management decisions based on expected fetal neonatal weight and a major problem in the decision making process seems to be the inability to estimate fetal weight accurately prior to delivery ***(Heiskanen et al., 2006).***

Moreover, many epidemiological studies supported the hypothesis that those born with low birth weight are at an elevated risk of developing type 2 diabetes, obesity, coronary heart diseases and hypertension during adulthood ***(Yan et al., 2006)***.

On the other hand, nearly, 10% of all newborns weight 4000gm or more. Birth weights beyond 4000gm are known to be associated with complicated deliveries especially shoulder dystocia and brachial plexus injury, that bear the most significant long term consequences ***(Gilber et al., 1999)***.

Shoulder dystocia occurs in 0.2% of all deliveries but its incidence rises to 5% in birth weight of 4000-4500gm and up to 30% in babies larger than 4500gm. Moreover, 50% of the cases of shoulder dystocia occur in babies weighting <4000gm. In 10% of reported cases of shoulder dystocia, brachial plexus injury is found but about 90% of those are temporary ***(Weiner et al., 2002)***.

Ultrasonographic Estimation of Fetal Weight

Introduction:

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