Abstract

Background: Abdominal circumference (AC), biparietal diameters (BPD) and femoral length (FL) are now the main parameters used to obtain estimated fetal weight (EFW). Although the role of soft tissue parameters in determining fetal weight was proved but clinical attention to mid-thigh soft tissue thickness (STT) is limited.

Objective: To find the impression of STT on birth weight (BW) and represent a new predictive formula.

Materials and Methods: One hundred and fourteen normal singleton term (37-39w) pregnancies with delivery in the same day were randomly selected to participate in this prospective cohort study. Variables measured by ultrasonography before birth included: AC, BPD, FL and STT. The actual neonatal BW was also measured after birth. Linear regression model was used and R square and p-value were reported.

Results: The mean (SD) of BW was 3406 (405) gr. R square was best fit for the model that STT was added to AC, BPD, FL (r2: 0.77). R square for the model using BPD, AC, FL and model using BPD, STT, FL was the same (r2: 0.7). Best fit formula was Log (BW)= 2.461+0.003BPD+0.001AC+0.007STT+0.005FL. AC (R: 0.67, $p<0.001$), STT (R: 0.50, $p<0.001$), BPD (R: 0.59, $p<0.001$), FL (R: 0.66, $p<0.001$) were significantly correlated with birth weight. AC had also significant correlation with STT (p=0.001)

Conclusion: This study showed adding STT to other variables in predictive models of fetal weight would provide a nice estimation (r2=0.74) and in cases that measuring AC is suboptimal STT may be a good replacement. Key words: Fetal weight, Soft tissue thickness, Abdominal circumference, Ultrasonography, Biparietal diameters, Femoral length.

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Introduction

Accurate estimation of fetal weight is a major concern in perinatal care, because of abnormal intrauterine growth is associated with increased neonatal morbidity and mortality ***(Bennini et al., 2010).***

Estimation of fetal weight is essential in daily obstetric practice, before delivery or at third trimester for women with potential risk of intrauterine growth restriction (IUGR) or macrosomia. It guides obstetricians to make up their decisions as regard time and mode of delivery to guard against complications of low birth weight (LBW) and macrosomic babies during labor and puerperium ***(Owen et al., 2003).***

The perinatal complication associated with low birth weight are most often attributable to fetal prematurity, but may sometimes arise as a result of intrauterine growth restriction ***(Jolly et al., 2003).***

Perinatal complications associated with macrosomic fetuses include shoulder dystocia, brachial plexus injuries, bony injuries and intrapartum asyphaxia, as well as maternal risk that include birth canal injures, pelvic floor injuries and post partum haemorrhage ***(Jolly et al., 2003).***

Birth weight is an important factor in delivery management. In extreme ranges of weight (<10th and >90th percentile) poor outcome is considerable. Higher birth weight is associated with both fetal and maternal complications ***(Mocanu et al., 2000).*** To estimate fetal weight, ultrasonography is the most common ***(Peregrine et al., 2007).*** However the sensitivity and specificity does not have wide difference (12.6% and 92.1% for ultrasonography and 11.8% and 99.6% for clinical palpation respectively) ***(Ashrafganjooei et al., 2010).***

The assessment of fetal size and growth has essentially been based on predictive models derived from two-dimentional (2D) ultrasound measurements. althoughwidely used in routine clinical practice, these formulae provide weight estimates with errors of up to 20% when compared with actual birth weights ***(Hsieh et al., 1987).***

Initial attempts to estimate fetal weight by ultrasound consisted of individual fetal measurements such as biparietal diameter (BpD) or abdominal circumference (AC), and femur length (FL), accuracy of estimated fetal weight is improved when multiple fetal measurements are used. The simplest methods that give reasonably accurate results are based on two measurements, AC and BpD or AC and FL ***(Song et al., 2000).***

Sonographic assessment of fetal growth for the estimation of fetal weight (EFW) is a common practice in obstetrics, providing valuable information for planning the mode of delivery and management of labor. Most formulae were proposed in the early 1980s using different combinations of standardized fetal biometric parameters, such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) ***(Dudley, 2005).***

Unfortunately, the accuracy of EFW is compromised by significant intra- and interobserver variability, and many of the existing formulae are generally inaccurate at the extremes of fetal weight ***(Kurmanavicius et al., 2004).***

AC is widely recognized as the most useful dimension with which to evaluate fetal growth, although it is subject to larger variability compared with linear measurements ***(Chang et al., 1993).***

None of these parameters, however, accounts for increased soft tissue mass, which leads to an underestimation of fetal weight ***(Dudley, 2005).***

This has been demonstrated in infants of diabetic mothers ***(Bernstein and Catalano, 1992).*** In whom the increased lean body mass was not estimated by standard measurements. For many years fetal weight has been assessed by taking a combination of standard two-dimentional measurement that are related to three anatomic sites: the fetal head, the fetal abdomen, and the femur. None of the established formulas ***(Hadlock et al., 1985).*** However, considers soft tissue thickness despite evidence that abnormal tissue content may be a reliable indicator of fetal growth aberrations ***(Deter et al., 1995).***

Aim of the work

To find the impact of STT on estimated fetal weight and the accuracy of it on the fetal weight

- ***Research question:*** In term pregnancy does the use of fetal mid thigh soft tissue thickness increase the accuracy of EFW?
- ***Research hypothesis:*** In term pregnancies the use of STT may increase the accuracy of EFW.

Chapter 1

Cesarean Section

Definition

Cesarean delivery is defined as the birth of a fetus through incisions in the abdominal wall (laparotomy) and the uterine wall (hysterotomy). This definition does not include removal of the fetus from the abdominal cavity in the case of rupture of the uterus or in the case of an abdominal pregnancy ***(Cunningham et al., 2009)***.

Cesarean delivery is the most common obstetric intraperitoneal operation, and the number of Cesarean deliveries is increasing worldwide ***(Malvasi et al., 2009)***.

Recently cesarean sections have been performed upon maternal request for deliveries that should be otherwise normal ***(Okonkwo et al., 2012).***

The uterus in pregnancy

The function of the uterus in pregnancy is to retain the developing fetus and to provide a protected environment until a stage at which the fetus is capable of surviving ex utero. The uterus must grow, facilitate delivery of the fetus and then involute. At the same time smooth muscle cells must be stretched by the growing fetus without producing miscarriage or premature labour ***(Standring et al., 2008).***

The uterus grows dramatically during pregnancy, increasing in weight from about 50 g at the beginning of pregnancy to up to 1 kg at term. Most of the weight gain is the result of increased vascularity and fluid retention in the myometrium. The increased growth of the uterine wall is driven by a combination of mechanical stretching and endocrine input. The mechanical load that the growing fetus imposes on the uterine wall induces hypertrophy of uterine smooth muscle cells, and is the major stimulus that increases smooth muscle mass. Some hyperplasia occurs early in pregnancy, mainly from the growth of the media of the myometrial arteries and veins. The myometrium is relatively unresponsive to additional endocrine stimulation during most of pregnancy, a relative quiescence that is in part attributed to progesterone. However, a number of growth factors, e.g. insulin-like growth factor-1 (IGF-1), have been identified which interact with oestrogen in promoting uterine growth. The myometrium thins with advancing gestation from 2-3 cm thick in early pregnancy to 1-2 cm at term ***(Standering et al., 2008).***

The upper third of the cervix (isthmus) is gradually taken up into the uterine body during the second month to form the ‘lower segment' (Fig. 1). The isthmus hypertrophies like the uterine body during the first trimester and triples in length to about 3 cm. From the second trimester the wall of the isthmus and that of the body are the same thickness and their junction is no longer visible externally. This condition persists until the middle of the third trimester when the junction between the body and the isthmus can sometimes be recognized as a depression is thicker than that below. The depression forms just below the vesico-uterine pouch and is thought to correspond to the level of the anatomical internal os (upper margin of lower segment). It is the anatomical landmark used at the time of a lower segment Cesarean section to ensure that the uterine incision is not in the body of the uterus. The lower segment is less vascular than the upper part of the transverse linear depression; the musculature above the uterus. Moreover, the risk of rupture of a lower segment uterine scar in subsequent pregnancies is significantly reduced compared to rupture of a scar in the body of the uterus (classical Cesarean section) ***(Standering et al., 2008).***

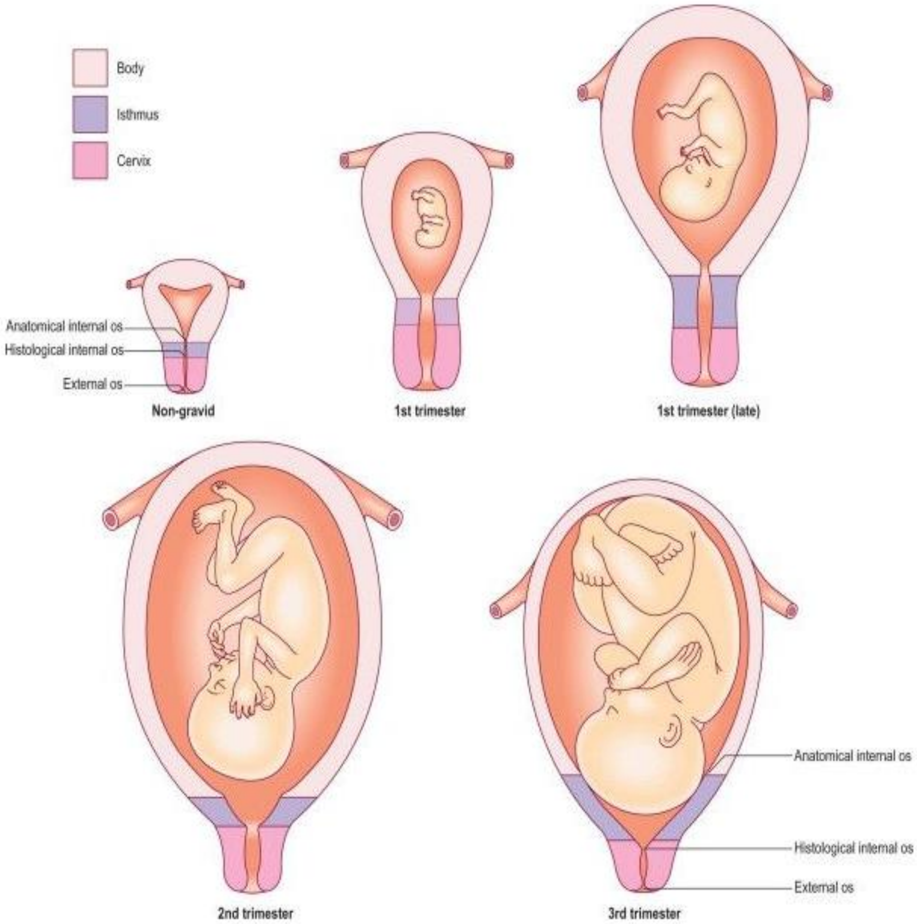


Figure (1): Frontal view of the uterus showing the location and extent of the body, isthmus and cervix in the non-gravid and gravid uterus at different stages in gestation. The isthmus forms the lower uterine segment with advancing gestation ***(Standering et al., 2008).***

Incidence of the Cesarean section

From 1910-1928, the cesarean delivery rate at Chicago Lying-in Hospital increased from 0.6% to 3%. The cesarean delivery rate in the United States was 4.5% in 1965. According to the National Hospital Discharge Survey, the cesarean rate rose from 5.5% in 1970 to 24.1% in 1986 ***(Saju et al., 2014).***

It was predicted that if age-specific cesarean rates continued at the steady pattern of increase observed since 1970, 40% of births would be by cesarean in the year 2000.

Those predictions fell short, but not by much. The National Center for Health Statistics reported that the percentage of cesarean births in the United States increased from 20.7% in 1996 to 32% in 2007.Cesarean rates increased for women of all ages, races/ethnic groups, and gestational ages and in all states (see the image below). Both primary and repeat cesareans increased ***(Saju et al., 2014).***

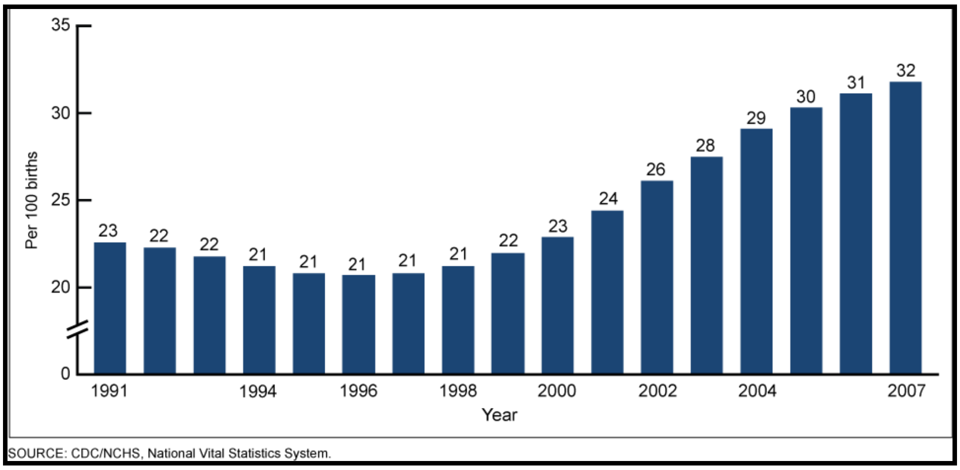
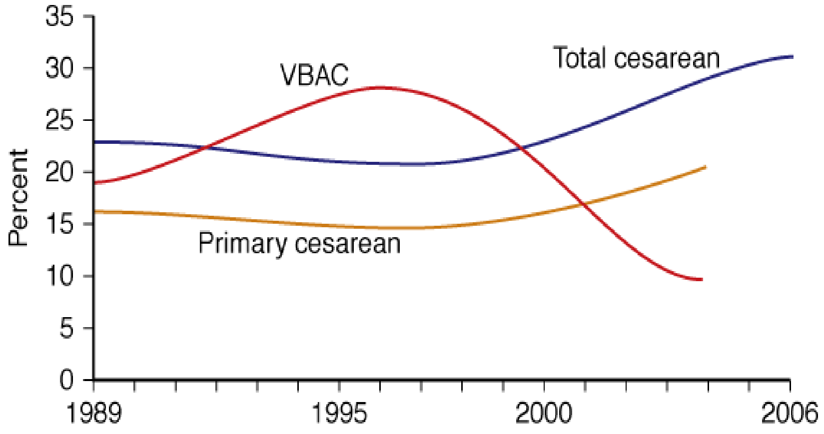


Figure (2): Cesarean delivery rates, United States.

Increases in the primary cesareans with no specified indication were faster than in the overall population and appear to be the result of changes in obstetric practice rather than changes in the medical risk profile or increases in maternal request ***(Saju et al., 2014).***



Source: Cunningham FG, Leveno KJ, Bloom SL, Hauth JC, Rouse DJ, Spong CY: *Williams Obstetrics, 23rd Edition:* http://www.accessmedicine.com

Figure (3): Percentage Rate VBAC in comparison primary rate ***(Cunningham et al., 2009).***

Cesarean Section Rates in USA and Europe:

As regard to USA cesarean sections increased dramatically during the 1970s and 1980s, reaching a peak of 24.7 per 100 deliveries in 1988 then between 1988 and 1994 the rate has reached a plateau at around 21 to 22 per 100 deliveries ***(Curtin et al., 2010).***

Cesarean section rates in Egypt:

Regarding Egypt, a significant rise in Cesarean deliveries has been occurred for all births from a low of 4.6% in 1992 to 10.3% in 2000. However, hospital-based Cesarean deliveries were much higher in 1988 (13.9%), increasing to 22.0% in 2000. Although the Cesarean section rate was slightly higher in private hospitals, the rate also increased consistently in public hospitals. This high increase in Cesarean section rates may be partly due to Cesarean sections that are not medically indicated, and suggest that physician practice patterns, financial incentives or other profitability factors, and patient preferences should be explored ***(Yassin et al., 2012).***

The CS rates limits used to define underuse and overuse may be a matter for discussion since any classification has some constraints. The 15% upper limit that was suggested by WHO in 1985 could be less valid nowadays taken in account changes of the population in high income countries, such as mother’s age at the first child, birth weight and other factors that may result in needing more or less CS. However, as we mentioned above, recent studies have shown that until now there is no evidence of benefit for the health of mothers and babies in populations with values of CS above 15***% (Luz et al., 2010).***

The reasons for the continued increase in the Cesarean rates are not completely understood, but some explanations include the following: ***(Cunningham et al., 2009)***.

1. The average maternal age is rising, and older women, especially nulliparous, are at increased risk of Cesarean delivery.
2. The use of electronic fetal monitoring is widespread. This technique is associated with an increased Cesarean delivery rate compared with intermittent fetal heart rate auscultation. Although Cesarean delivery performed primarily for "fetal distress" comprises only a minority of all such procedures, in many more cases, concern for an abnormal or "non reassuring" fetal heart rate tracing lowers the threshold for Cesarean deliveries performed for abnormal progress of labour.
3. Most fetuses presenting as breech are now delivered by Cesarean.

4. The incidence of forceps and vacuum deliveries has decreased.
5. Rates of labour induction continue to rise, and induced labour, especially among nulliparous, increases the risk of Cesarean delivery.
6. The prevalence of obesity has risen dramatically, and obesity increases the risk of Cesarean delivery
7. Rates of Cesarean delivery for women with preeclampsia have increased, whereas rates of labour induction in these patients have declined ***(Basso et al., 2006).***
8. Vaginal birth after Cesarean-VBAC-has decreased from a high of 26 percent in 1996 to a rate of 8.5 percent in 2007 ***(Hamilton, 2009).***
9. Elective Cesarean deliveries are increasingly being performed for a variety of indications including concern for pelvic floor injury associated with vaginal birth, medically indicated preterm birth, to reduce the risk of fetal injury, and for patient request ***(Ananth and co-workers, 2005; Nygaard and Cruikshank, 2013).***
10. Malpractice litigation continues to contribute significantly to the present Cesarean rate. In a compilation of medical malpractice claim data for the years 1985 through 2003, obstetrics accounted for the largest number of claims paid ***(Texas Medical Liability Trust, 2014).***
11. The Cesarean section rate was significantly higher among IVF patients (41.9% versus 15.5%). The rates of preterm

labor, low birth weight, small and very small for gestational age, neonatal intensive care unit admissions, and mortality were comparable ***(Reubinoff et al., 1997).***

A brain-damaged infant was one of the most prevalent patient conditions, and overall, the average indemnity paid on obstetrical claims was 28 percent greater than for the other 24 specialties included in the report. This data is especially troubling in view of the well-documented lack of association between Cesarean delivery and any reduction in childhood neurological problems. According to Foley and colleagues, the incidence of neither neonatal seizures nor cerebral palsy diminished as the rate of Cesarean delivery increased ***(Foley, 2012).***

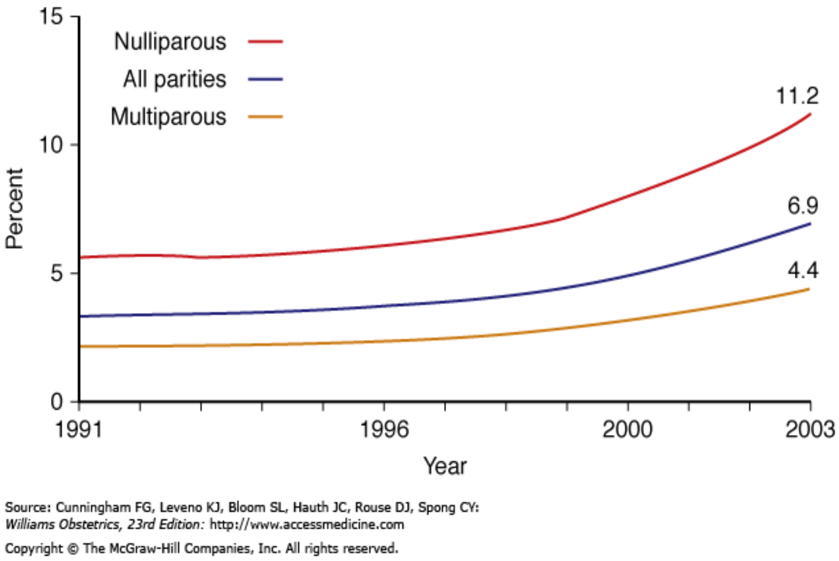


Figure (4): Rate of increasing maternal age exposed to caesarian section ***(Cunningham et al., 2009).***

Methods to Decrease Cesarean Delivery Rates:

Programs aimed at reducing the number of cesarean deliveries generally are focused on educating physicians, peer reviewing, encouraging a trial of labor after prior transverse cesarean delivery, and restricting cesarean deliveries for dystocia only to women who meet strictly defined criteria ***(Saju et al., 2014).***

The most recent recommendation from the American College of Obstetricians and Gynaecologists (ACOG) regarding breech delivery is that planned vaginal delivery may be reasonable under hospital-specific protocol guidelines for both eligibility and labour management. This may lead to a small decrease in breech delivery rates, but the overwhelming majority of cases will probably continue to be delivered by elective Cesarean ***(Saju et al., 2014).***

In a recent randomized study from 34 Latin American hospitals reported that a mandatory second opinion was associated with a small but significant reduction in the cesarean delivery rate without an adverse effect on maternal or perinatal morbidity or mortality ***(Williams's obstetrics, 2009).***

Indications of Cesarean Section:

A cesarean delivery is performed for maternal indications, fetal indications, or both. The leading indications for cesarean delivery are previous cesarean delivery, breech presentation, dystocia, and fetal distress. These indications are responsible for 85% of all cesarean deliveries ***(Saju et al., 2014)***.