"EVALUATION OF VARIOUS FOETAL BIOMETRIC PARAMETERS BY ULTRASOUND IN NORMAL PREGNANT WOMEN IN LOCAL POPULATION"

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.
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ABSTRACT

OBJECTIVES:

Sonographic determination of fetal size, for the purpose of gestational age determination or the detection of fetal growth anomalies is an extremely important part of modern prenatal care.

Many variables affect fetal growth such as maternal illness, drug exposure, genetic syndromes, congenital anomalies, placental insufficiency and others. Previous reports have shown that ethnicity plays a role in fetal growth. Even within a population, geographical changes such as altitude can affect normal fetal size. Thus, each particular population or ethnic group should have their own reference values for the different fetal anthropometrical variables in order to provide accurate assessments which helps in detecting fetal abnormalities better.

Fetal biometric parameters are not standardized in Indian scenario, hence present study is undertaken to determine whether there is any variation. This study helps for better evaluation of fetal abnormalities.

METHODS:

Hundred normal singleton pregnant women i.e fifty pregnant women with gestational age between 18 to 24 weeks and fifty pregnant women with gestational age between 28 to 34 weeks, with proper menstrual history and known last menstrual period with no maternal complications are subjected to ultrasound for obstetric examination in the department of radiology, Vydehi institute of medical science, Bangalore.

All examinations are performed using a gray-scale real time sonography machines, Philips HD 15 and Philips HD 7. BPD, HC, AC and FL parameters are measured and then compared with western nomograms.

RESULTS:

In our study we found that the accuracy of each parameter decreases as gestational age increases. Observations show that mean gestational is little more accurate in predicting gestational age than individual parameter.

CONCLUSION: Our study reveals the use of multiple fetal biometric parameters (BPD, HC, FL, AC) to predict the most accurate gestational age and determine EDD. Our study shows that fetal anthropometric measurements significantly differ among different population groups due to racial, genetic and ethnic factors. Hence a large scale study at notional level in Indian population is required to generate population specific tables and regression equations

Keywords: Ultrasound, Bi-parietal Diameter, Head Circumference, Abdominal Circumference, Femurlength, Hadlock

LIST OF ABBREVIATIONS

1.	BPD	:	Bi-parietal Diameter.
2.	HC	:	Head Circumference
3.	AC	:	Abdominal Circumference
4.	FL	:	Femur Length
5.	P	:	Present
6.	H	:	Hadlock
7.	USG	:	Ultrasonography

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Introduction

INTRODUCTION

Fetal biometry is an important part of the regular examinations performed during the second and third trimesters of pregnancy. This type of examination during pregnancy became popular with the introduction of ultrasound technology in clinical practice and today, the use of ultrasound in the measurement of fetal parts is referred to as ultrasonic fetal biometry. Before the introduction of ultrasound in medicine, radiological imaging was used in the assessment of the status of the fetus in utero though in a limited way because of its risk factors.

Gestational age is the age of an unborn baby[1]. The accurate knowledge of gestational age is the key for successful antepartum care and critical interpretation of antenatal tests and successful planning of appropriate intervention or treatment.

In past, gestational age has been established by combination of historical information and physical examination. Predications were based on menstrual history, maternal sensations of fatal movements, assessment of uterine size by bimanual examination in the first trimester, initial detection of fatal heart tones by doppler and uterine fundal height measurement[71-76].

However its been reports that even in the best known cases, the menstrual history index and fundal height technique were also fraught with error. timed ovulation and in vitro fertilization with known date of conception are expected to estimate the gestational age accurately. Unfortunately, the last menstrual period cannot be used for all patients because 10 to 40% of all patients seen in the antenatal clinics have no knowledge of there LMP or a history of irregular menstrual cycles or have been on oral contraceptives within two months of there LMP

Determining the gestational age from the palpated dimensions of the uterus may be effected

by uterine fibroids and maternal body habits. there fore in most pregnant the date of ovulation or conception cannot be accurately predicted as outlined by other methods and hence gestational age must be estimated by other methods.

Sonographic measurements of the fetus provide information about fetal age and growth. They are used to assign gestation age, EDD, estimated fatal weight, and diagnose growth disturbances.

Fetal biometry is a method devoted to the measurement of several parts of fatal anatomy and their growth. Real time ultrasound scanners are given a number of ultrasound biometric parameters to determine gestational age. the most commonly used biometric parameters are crown rump length(CRL), bi-parietal diameter (BPD), head circumference (HC), abdominal circumference(AC), femur length (FL) to determine gestational age, fatal weight and growth in different trimesters. in the absence of known date of LMP or their fundal height does not agree with dates, these parameters are valuable in estimating the gestational age of fetus.

Standard fetal growth charts and tables as given by the previous workers of obstetric ultrasound evaluate weather the dimensions of a particulate parameter are normal for that age. Since fatal growth is very rapid, fatal growth parameters change significantly with gestational age and must be evaluated against normal tables or graphs. The prenatal measurement of fatal parameters and estimated size and weight vary among different populations, depending upon the racial demographic characteristics and nutrition. Biometric curves and growth charts for one population may over estimate or underestimate the fatal age when used for another population with different demographic characteristics. And as the fetal development is subjected to many factors such as maternal race, ethnic and socio-economic status etc., there is over diagnosis of IUGR.

Unfortunately the obstetric tables used in our country are produced from the data collected in

the population of developed countries which may vary from our population.

Therefore, the present study was undertaken to assess the gestational age in the second and third trimesters (only from 18 to 24 weeks and 28 to 34 weeks) with help of sonographic measurements of four fatal biometric parameters in local population and to compare these values with western nomograms. Many variables affect fetal growth such as maternal illness, drug exposure, genetic syndromes, congenital anomalies, placental insufficiency and others. Previous reports have shown that ethnicity plays a role in fetal growth. Even within a population, geographical changes such as altitude can affect normal fetal size. Thus, each particular population or ethnic group should have their own reference values for the different fetal anthropometrical variables in order to provide accurate assessments which helps in detecting fetal abnormalities better.

Fetal biometric parameters are not standardized in Indian scenario, hence present study is undertaken to determine whether there is any variation. This study helps for better evaluation of fetal abnormalities.

Aim and objective

AIMS AND OBJECTIVES

1. To study variation of fetus biometric parameters in normal pregnancies.

2. To evaluate and compare with those of established biometric parameters

Review of literature

REVIEW OF LITERATURE

Sonographic measurements of the fetus provide information about fetal age and growth. These data are used to assign gestational age, estimate fetal weight, and diagnose growth disturbances.

It is important to begin by defining the various terms used in the evaluation of the age of a pregnancy. The true measure of age is the number of days since conception, termed conceptional age**.** Historically, pregnancies were dated by the number of days since the first day of the last menstrual period (LMP), termed menstrual age. In women with regular 28-day cycles, menstrual age is 2 weeks more than conceptional age, because conception occurs approximately 2 weeks after the LMP in such women. Currently, the term most often used to date pregnancies is gestational age, defined as follows:

Gestational age (menstrual age)□=□Conceptional age +□2 weeks

In women with 28-day cycles, gestational age and menstrual age are equal. In women with longer cycles, gestational age is less than menstrual age; the opposite holds in women with shorter cycles.

The timing of chorionic villus sampling and screening tests in the first trimester, genetic amniocentesis in the second trimester, and elective induction or cesarean delivery in the third trimester are all based on the gestational age

The differentiation between term and preterm labor and the characterization of a fetus as "postdates" depend on gestational age. Knowledge of the gestational age can be critical in distinguishing normal from pathologic fetal development.

Estimation of the fetal weight, on its own and in relation to the gestational age, can influence

obstetric management decisions concerning the timing and route of delivery. Early delivery may benefit a fetus that is small for dates. Such a fetus may be inadequately supplied by its placenta with oxygen and nutrients and therefore may do better in the care of a neonatologist than in utero. When the fetus is large, cesarean section may be the preferred route of delivery, particularly in pregnancies complicated by maternal diabetes. In view of these considerations, fetal measurements should be a component of every complete obstetric sonogram.[7] In fact, virtually all important clinical decisions in obstetrics are influenced by gestational age.

Clinical dating of a pregnancy is usually based on the patient's recollection of the first day of her LMP and on physical examination of uterine size. Unfortunately, both these methods are subject to imprecision, leading to inaccuracies in gestational age assignment. Dating by LMP (menstrual age) may be inaccurate because of variability in length of menstrual cycles (early or late ovula- tion occurs in 20% of population), faulty memory, recent exposure to oral contraceptives, or bleeding during early pregnancy. Determining gestational age from the palpated dimension of the uterus may be affected by uterine fibroids, multiple pregnancy, and maternal body habitus.

Sonographic evaluation in First trimester

Sonographic milestones of early pregnancy and measurement of the embryo once it can be visualized by transvaginal ultrasound allow highly accurate dating from 5 weeks' gestation until the end of the first trimester.

The earliest sign of an intrauterine pregnancy is identification of a gestational sac in the uterine cavity. This appears as a round or oval fluid collection surrounded by one and sometimes two echogenic rings formed by the proliferating chorionic villi and the deeper layer of the decidua vera. It is first seen at approximately 5 weeks' gestation.[9-11]

From 5 to 6 weeks' gestation, two methods are used to assign gestational age by ultrasound:

(1) measurement of mean sac diameter (MSD)

(2) sonographic identification of gestational sac contents.

The MSD, the average internal diameter of the gestational sac, is calculated as the mean of the antero-posterior (AP) diameter, the transverse diameter, and the longitudinal diameter. It increases from 2mm at 5 weeks to 10mm at 6 weeks,[12] a growth pattern that can be used to assign gestational age during this period.

The second method, based on the sonographic findings within the gestational sac, is best done by transvaginal sonography and relies on the observation that, on average, the gestational sac is first identifiable at 5.0 weeks, the yolk sac at 5.5 weeks, and the embryo and embryonic heartbeat at 6.0 weeks[13]. From 6.3 weeks onward, ultrasound will visualize an embryo 5 mm or greater in length, by which time a heartbeat should always be seen if the embryo is alive. The timing of these milestones is subject to some variability, but they usually are seen within 0.5 week of the stated gestational ages. Gestational age can be assigned based on these milestones

From 6 weeks until the end of the first trimester, gestational age correlates closely with the crown-rump length (CRL) of the embryo or fetus.[14,15] The term embryo is used up to 8 to 10 weeks' gestation, and the term fetus applies thereafter.[16] The CRL is the length of the embryo or fetus from the top of its head to the bottom of its torso. It is measured as the longest dimension of the embryo, excluding the yolk sac and extremities. The CRL can be used to assign gestational age accurately up to 11 weeks because minimal biologic variability occurs during this time. After 12 to 13 weeks' gestation, the CRL of the longer, more developed

fetus becomes less reliable. At this later stage, the CRL is affected by the fetal position, measuring shorter in a fetus whose spine is flexed and longer in a fetus whose spine is extended.

The accuracy of gestational age determination by ultrasound, as measured by the width of the 95% confidence range, is approximately _+ 0.5 week throughout the first trimester.[14,15] The sonographic estimation of gestational age will be within 0.5 week of the actual age in 95% of cases.

Figure:1. Crown Rump length is measured. Measured from top of its head to torso. The yolk sac should not be included in the fetal CRL measurement.

Figure:2. A single gestational sac containing yolk sac.

Figure:3. Measurement of CRL at 12w 6d.

Evaluation in second and third trimesters

Many sonographic parameters have been proposed for estimating gestational age in the second and third trimesters. These include several fetal measurements: bi-parietal diameter (BPD),[17,18] head circumference (HC),[19] abdominal circumference (AC),[20] femur length (FL),[18,21-23] length of other long bones,[22] and binocular distance,[24] as well as combinations of two or more fetal measurements and composite age formulas.[20,26] Measurements of structurally abnormal fetal body parts should not be used in the assignment of gestational age.

Biparietal Diameter (BPD)

This parameter is used in the second trimester, from 12th week onwards. It measures the maximum distance between the two parietal bones taken from the leading edge of the skull to the outer to inner leading edge (Hadlock *et al*., 1982). It can also be measured from outer to outer table of the skull. This axial plane passes through the widest portion of skull where the continuous midline echo of falx cerebri is broken by cavum septum pellucidum with both the thalami enclosing the slit like opening of the 3rd ventricle of brain. Studies report the growth of the BPD in the mid trimester is linear and rapid and biological variation at each week of gestation is small. The measurement of BPD from 14 – 26 weeks predicts the correct duration of gestation to the extent of ± 9 days in 95% of cases, however, the measurement of the parameter in second trimester (16 – 20weeks) routine scan is performed in all good antenatal care centers. At times, when the fetal head may be short and wide (brachycephaly) or long and flattened (dolicephaly), the assessment of age from BPD will be under or over estimated. Therefore, if the shape of head appears brachycephalic or dolicephalic; the cephalic index is calculated; and if found to be outside the normal range, the head circumference should be used to estimate age.

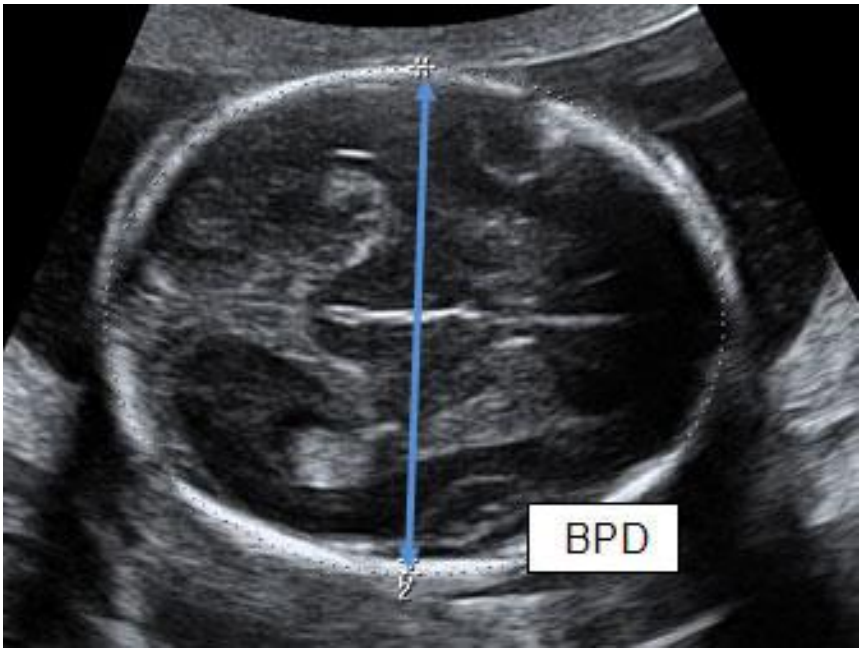


Figure:4. Biparietal diameter (BPD) measurement. Trans axial sonogram of the fetal head at the level of paired thalami. Note: Measurement of BPD is taken between the two parietal bones taken from the leading edge of the skull to the outer to inner leading edge.

Head Circumference (HC):

This parameter is used in the third trimester along with other parameters such as femur length (Ott, 1994; Warda *et al*., 1985; Exacoustos *et al*., 1991). HC is measured on the same plane as BPD, that is on an axial plane that traverses the thalami, and cavum septum pellucidum. The transducer must be perpendicular to the central axis of the head, and thus the hemispheres and calvaria should appear symmetric. The cerebellar hemispheres should not be in the plane of the image or the probe is too caudal giving an inaccurate size of the fetal head.

It is measured by using the ellipsoid mode of the machine and adjusting the elliptical calipers to the outer margin of the skull table. The accuracy of this parameter is ±2 – 3 weeks with 95% confidence interval.

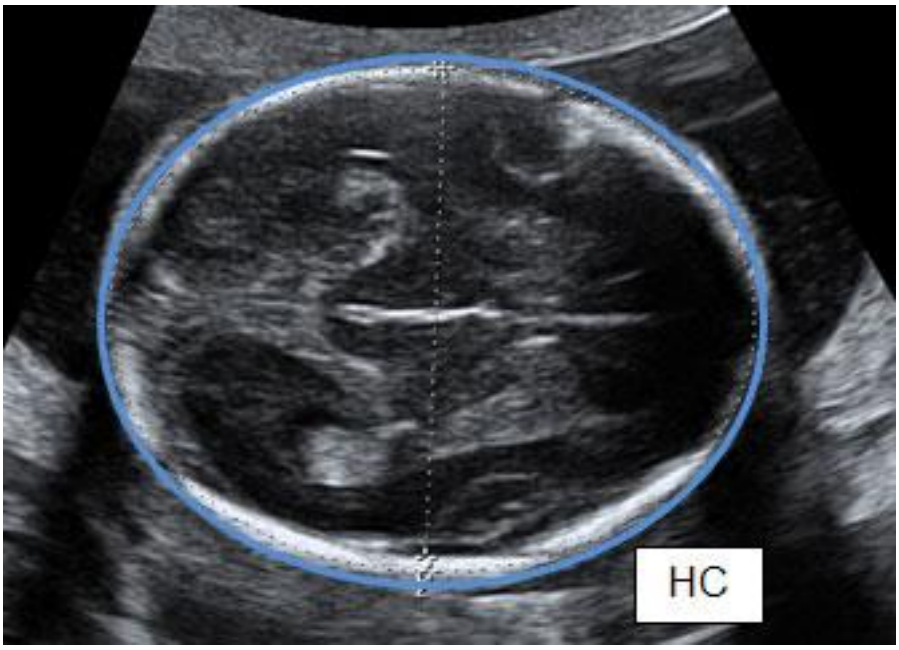


Figure:5. Head Circumference measurement. HC measurement at the same level as for the biparietal diameter measurement. Note: HC measurement is obtained from the perimeter of calvarium.

Abdominal Circumference (AC):

This ultrasonic fetal anthropometric parameter is less used for the assessment of gestational age. It is however, more used for monitoring fetal growth, especially in the third trimester and for estimation of fetal weight (Campbell and Wilkin, 1975). The abdominal circumference is taken at the level where the umbilical vein enters the left branch of portal vein; alternatively, a scan at a slightly lower level showing a short segment of the umbilical vein may be taken. The outline of the abdomen should be as circular as possible. Until 36 weeks of pregnancy, the head circumference is larger than the abdominal circumference, the HC: AC ratio is therefore more than 1, but after 36 weeks, the AC catches up with the HC, and then continues to grow at a faster rate, so that the ratio of HC to AC near term becomes less than one (Campbell and Thoms, 1977).

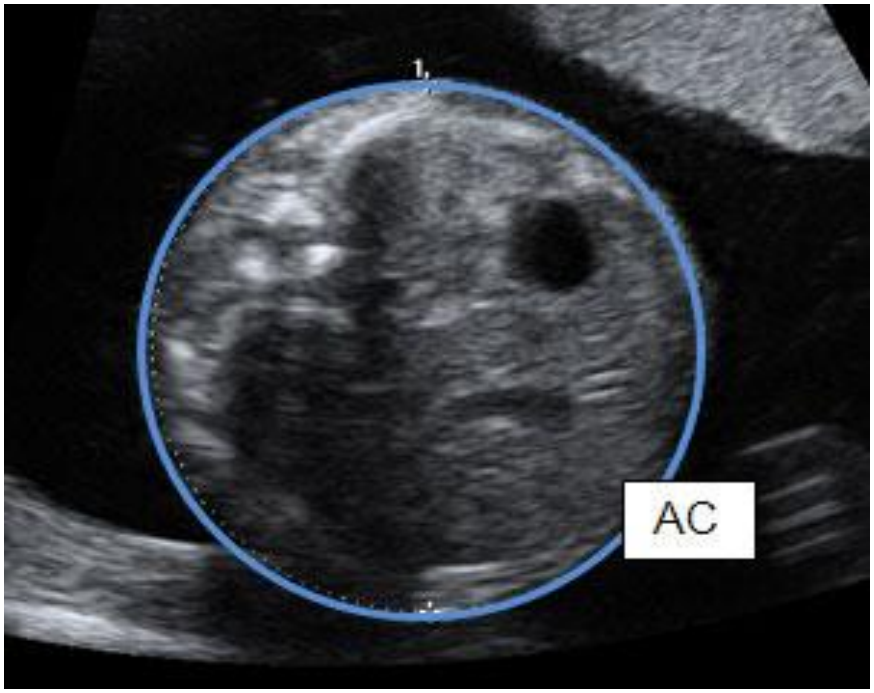


Figure:6. Abdominal Circumference measurement. Axial view of the fetal abdomen at the level of stomach and intrahepatic portion of the umbilical vein.

Femur Length (FL):

Femur length is a very useful anthropometric parameter in the second and third trimesters of pregnancy. It grows linear throughout and is best measured after 14 weeks of gestation (Deter *et al*., 1987; Chitty *et al*., 1994; Kurmanavicius *et al*., 1999

The diaphysis is measured from the greater trochanter above to the lateral condyle below. The outer border of femur is straight and the inner border is curved normally (Sharlon and Filly, 1985). The accuracy of gestational age calculation by FL is within 6 – 7 days of menstrual age at 95% confidence level (Brien *et al*., 1981). These four parameters are most frequently used for the estimation of gestational age and sometimes considered as the 'gold standard' and they collectively assess the gestational age to the highest degree of accuracy (Brien *et al*., 1981). 1.7

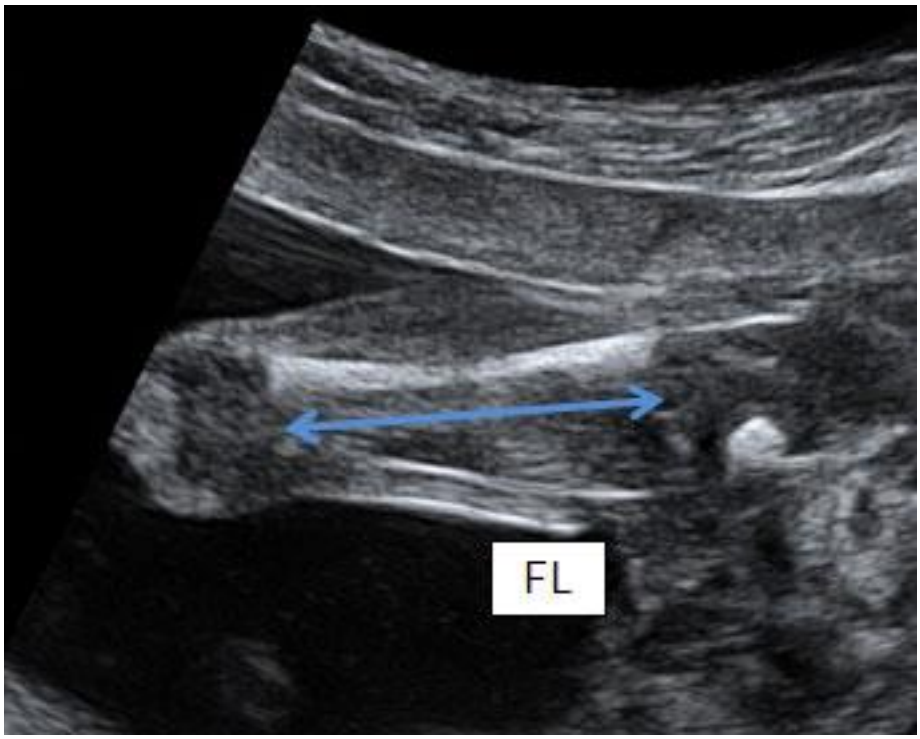


Figure:7. Femur length measurement. Femur length is measured from the greater trochanter to the lateral condyle, with both ends clearly visible. Note: closest to the maternal abdominal wall is measured.

OTHER LESS FREQUENTLY USED PARAMETERS

Parameters, less frequently used in the discipline of fetal anthropometry, include the fetal transverse thoracic diameter, thoracic circumference, and measurement of long bones, orbit and lens dimensions and fetal binocular distance.

Formulas used to calculate gestational age.

Gestational age can be estimated from measurements of the head, abdomen, or femur by means of tables or formulas that present the mean value of each measurement for a given gestational age. Composite age formulas that combine several fetal measurements can also be used to predict gestational age.[21,26]

The accuracy of gestational age determination ranges from 1.2 weeks for the HC and corrected-BPD between 14 and 20 weeks, to 3.5 weeks in the late third trimester for the FL. As pregnancy progresses, each parameter becomes less accurate.[18,31,32] The two fetal head measurements that take head shape into account, corrected-BPD and HC, are equivalent in accuracy and more accurate than the BPD throughout gestation. In the second trimester BPD and HC are the best predictors of gestational age. In the third trimester, these two head measurements, the FL, and the composite age formulas all predict gestational age with comparable accuracy[18,32,33].

Composite age formulas use two or more measurements in conjunction to estimate gestational age. A potential disadvantage of using such formulas is that an abnormal measurement or anomaly might be obscured. For example, in a fetus with a skeletal dysplasia manifested by shortened long bones and a normal head size, the gestational age based on the composite formula will be an underestimation, falling between that predicted by the corrected-BPD and that predicted by the short FL. As a result, the FL might not appear to be abnormally small when compared to this improperly calculated gestational age.

Table:1. Formulae used for Fetal weight estimation.

Formulae used for fetal weight estimation		
source	Year	formula
Shepard - BPD, AC	1982	Log_{10} BW = [-1.7492 + (0.166 x BPD) + (0.046 x AC) – (0.002646 x AC x BPD)] x 1000
Campbell - AC	1975	Log $_{10}$ BW = - 4.564 + (0.282 x AC) – 0.00331 $(AC)^2$
Hadlock I- AC,FL	1985	Log $_{10}$ BW = 1.304 + (0.05281 x AC) + (0.1938 x FL) – (0.004 x AC x FL)
Hadlock II- BPD,AC,FL	1985	Log $_{10}$ BW = 1.335 – (0.0034 x AC x FL) + (0.0316 x BPD) + (0.0457 x AC) + (0.1623 x FL)
Hadlock III- HC,AC,FL	1985	Log $_{10}$ BW = 1.326 – (0.0034 x AC x FL) + (0.0107 + (0.0438 x AC) + (0.158 x FL)
Hadlock IV- BPD,HC,AC,FL	1985	Log $_{10}$ BW = 0.3596 + (0.00061 x BPD x AC) + (0.0424 x AC) + (0.174 x FL) + (0.0064 x HC) – (0.00386 x AC x FL)

Estimation of Fetal Weight

Before the availability of ultrasound, manual examination of the maternal abdomen was the only approach that could be used to estimate fetal size. The physical examination, however, provides only a general approximation of fetal weight because the palpated dimensions of the uterus are affected by several factors other than fetal size, including amniotic fluid volume, placental bulk, presence of fibroids, and maternal obesity.

Sonographic measurements of fetal body parts provide a direct way of assessing fetal size. Numerous formulas have been published for estimating fetal weight from one or more of these fetal body measurements: head (BPD or HC), abdomen (AD or AC), and femur (FL).[37-46] Other measurements, such as thigh circumference, have been used as well.[46] Formulas that estimate fetal weight using three-dimensional (3-D) sonography[47-49] and 3-D magnetic resonance imaging (MRI) have also been published.[50,51]

The accuracy of a weight prediction formula is determined by assessing how well the formula works in a group of fetuses scanned close to delivery. An important measure of a formula's performance is its 95% confidence range. If the 95% confidence range is +_18%, for example, the estimated weight will fall within 18% of the actual weight in 95% of cases, and the error will be greater than 18% in only 5% of cases. The narrower the confidence range, the more reliable is the formula.

Many published studies provide information that allows one to estimate this measure of a formula's accuracy. The following points are noteworthy:

The accuracy of weight prediction formulas improves as the number of measured body parts increases up to three, achieving greatest accuracy when measurements of the head, abdomen,

and femur are used. There is no apparent improvement by adding the thigh circumference as a fourth measurement,[54] and no proven benefit from using 3-D sonography or MRI.

Even when based on measurements of the head, abdomen, and femur, sonographic weight prediction has a rather wide 95% confidence range of at least _+15%. Based on the abdomen and either the head or femur, the range is at least _+16%-18%. Precision is considerably worse when only the abdomen is used.

A number of factors have been studied to determine their effect on accuracy of weight prediction. Accuracy appears to be worse in fetuses that weigh under 1000 grams than in larger fetuses.[53] Over the rest of the birth weight range, however, accuracy is fairly constant.[43,44,52,55] Weight prediction is less accurate in diabetic than in non diabetic mothers. In diabetic mothers, formulas that use measurements of the head, abdomen, and femur have a 95% confidence range of _+24%,[56] wider than the range of _+15% in the general population.[43,44] The presence of oligohydramnios or polyhydramnios has no impact on accuracy.[41,53,57] Scan quality may have an effect on accuracy. Studies have shown a trend toward greater accuracy in scans that were rated "good" compared with those rated "poor" based on ability to visualize anatomic landmarks.[53,58]

Recommended approach

An attempt should be made to image all three key fetal anatomic regions—head, abdomen, and femur—at the appropriate anatomic levels. If measurements of all three structures can be obtained, Formula 1 in below given table should be used to estimate fetal weight. This formula should be used with the corrected-BPD when the OFD is available, and with the

BPD itself if not. An alternative approach, equally accurate but more cumbersome, would be to use Formula 1 when the OFD is unavailable, and a formula based on HC, AC, and FL when the OFD is available. If the abdomen and only the head or the femur can be appropriately imaged, Formula 2 or 3 should be used. If the abdomen cannot be measured, or both the head and femur cannot be measured, then a weight estimate should not be calculated. Using the approach outlined in below given table, an accuracy of _+15%-18% can be achieved for weight estimation.

Table:2. Approach to fetal gestational age estimation

Approach to fetal age estimation	
Body parts measured	Formula
Head, abdomen and femur	$Log_{10}(EFW>)=1.4787\square 0.003343AC\cdot FL+0.001837BPD_2 + 0.0458\ AC + 0.158\ FL$
Head and abdomen	$Log_{10}(EFW>)=1.1134+0.05845AC\square 0.000604AC^2 \square\ 0.007365BPD^2 +0.00595BPD\cdot AC+0.1694BPD$
Abdomen and femur	$Log_{10}(EFW)=1.3598+0.051AC+0.1844FL\square 0.0037\ AC * FL$

Weight assessment in relation to gestational age

When an ultrasound is performed in the third trimester, best estimates of gestational age and fetal weight should be established. The gestational age may be based on a prior ultrasound, clinical dating criteria, or current measurements; fetal weight is always calculated from current measurements. The two values should be cross-assessed to determine whether the fetus is appropriate in size for dates. This can be accomplished by using a table that provides norms of values for fetal weight as a function of gestational age, several of which appear in the literature.[59-64]

As an example, suppose that an obstetric sonogram reveals the best estimated gestational age is 34 weeks**.** According to, a weight of 2146 grams (g) corresponds to the 50th percentile, and weights of 1714 g and 2687 g correspond to the 10th and 90th percentiles, respectively. A weight between the 10th and 90th percentiles is generally considered to be "appropriate for gestational age." When the estimated weight falls outside this range, the diagnosis of a small-for-gestational-age or large-for-gestational-age fetus is suggested.

When fetal weight is estimated on a third-trimester sonogram and a weight percentile is determined, correct interpretation of that percentile should take into account how weight percentile tables are derived. Such tables are, of necessity, derived from birth weights of neonates, versus estimated weights of fetuses, because only neo- natal weights are known. For example, the mean and standard deviation of weight at 27 weeks' gestation is determined from data on birth weights of babies born at 27 weeks' gestation. It is important to note that several studies have shown that small fetuses have an increased likelihood of early delivery, so neonates born at 27 weeks' gestation are, on average, smaller than fetuses remaining in utero at that gestational age.[65-67] It follows that more than 50% of 27-week fetuses will have an estimated weight above the 50th percentile, and fewer than 10% will fall below the 10th percentile.

The weight gain between two ultrasound examinations can be estimated as the difference between the two estimated weights. Adequacy of weight gain can be assessed by comparing this difference to established normal fetal growth rate as a function of gestational age. Brenner's data indicate that median fetal weight gain per week increases progressively until 36 weeks of gestation, reaching a maximum rate of 220 grams per week.[59,60] After 36 weeks, the rate of weight gain steadily decreases in the normal fetus. The longer the time between scans, the more accurate is the sonographic estimate of interval weight gain. When two scans are performed within 1 week of each other, weight gain cannot be determined reliably, so there is little or no value in computing an estimated weight at the time of the second scan.

When several examinations have been performed, fetal growth can be depicted graphically by means of a trend plot, or growth curve. One form of growth curve plots the estimated fetal weight versus gestational age, with the curve for the fetus being examined superimposed on lines depicting the 1st, 10th, 50th, 90th, and 99th percentiles. An alternative mode of display plots the estimated weight percentile versus gestational age. In this latter format, the graph for a normally growing fetus will be a horizontal line, indicating maintenance of a particular weight per- centile throughout gestation. A down sloping line indicates a subnormal growth rate, and an up sloping line indicates accelerated growth.

Calculation of weight percentiles and plotting of growth curves is most easily accomplished by computer, using an obstetric ultrasound software package that per- forms these tasks.[68-70] Alternatively, similar results can be achieved by means of a calculator and manual plotting of data.

Table:3. Fetal weight percentiles in third trimester

Fetal weight percentiles in third trimester			
Gestational age	10th	50th	90th
25	490	660	889
26	568	760	1016
27	660	875	1160
28	765	1005	1322
29	884	1153	1504
30	1020	1319	1706
31	1171	1502	1928
32	1338	1702	2167
33	1519	1918	2421
34	1714	2146	2687
35	1919	2383	2959
36	2129	2622	3230
37	2340	2859	3493
38	2544	3083	3736
39	2735	3288	3952
40	2904	3462	4127

Giorgia Buscicchio, et al[3] did a study in one thousand normal pregnant women, between 22th and 23th weeks, between 32th and 33th weeks and at 38th week, were thoroughly

measured. There found significant differences in their data for each gestational age (femur length, abdominal circumference, head circumference and occipito-frontal diameter) in comparision with existing references. [1]

Prashanth acharya, et al did a study in normal singleton pregnancies and found that if western parameters of foetal biometry are applied to all patients IUGR/FGR may be over-diagnosed and bi-parietal diameter head circumference and femur length after 34th week and abdominal circumference after 30th are less when compared western growth charts.[2]

Sung il jung et, al did a study in foetal biometric parameters in normal pregnant women and found significant difference in these parameters in comperission with standard parameters and made new references and eqution for Koreans population.[3]

Dubiel M et al did a study in healthy volunteers with singleton pregnancies and found out that reference charts for Polish population are similar to foreign curves. Less variation was seen in comparison with national charts based on postnatal weigh.[4]

M. W. Pang, et al did study in foetal parameters in normal singleton pregnancies and found that Increased foetal head size and abdominal circumference were significantly associated with extremes of maternal age. Maternal height had a statistically significant influence on parietal diameter, Maternal weight had an influence on foetal abdominal circumference and femur length. Foetal sex was found to have a statistically significant influence on the final regression models of biparietal diameter, head circumference and femur length. Parity had an influence on foetal head circumference and abdominal circumference.[5]

Keeping, et al first introduced the concept of customized standard birth-weight charts based on their observations that neonatal birth weights differed among mothers with different pregnancy characteristics.[6]

Materials and methods

MATERIALS AND METHODS

All pregnant women are sent to our department for obstetric examination. Hundred normal singleton pregnant women i.e fifty pregnant women with gestational age between 18 to 24 weeks and fifty pregnant women with gestational age between 28 to 34 weeks, with proper menstrual history and known last menstrual period with no maternal complications are subjected to ultrasound for obstetric examination in the department of radiology, Vydehi institute of medical science, Bangalore.

I. Inclusion criteria – all singleton pregnant women

II. Exclusion criteria – 1.twin pregnancy

2. pregnant women with co morbid conditions

3. congenital anomalies

Imaging Protocol

All examinations are performed using a gray-scale real time sonography machines, Philips HD 15 and Philips HD 7 using a 2 to 5 MHz curvilinear transducer. Other materials used are aqua saline jelly and Sony ultrasound thermal paper roll.

Figure:8. Philips HD 15 ultrasound machine.

Figure:9. Philips HD 7 ultrasound machine.

Figure:10. Philips C5-2 curvilinear ultrasound probe.

A complete form – F (in compliance to PC&PNDT act) signed by the radiologist and the women undergoing sonography was taken prior examination. Each sonography was done after a complete antenatal check up by obstetrician. Detail personal obstetric and menstrual history was taken obtained. If no anomaly was seen, then the following four parameters are measured.

1.Bi-parietal diameter: Fetal head was imaged in axial plane. The BPD was measured from outer surface of the skull table near to the transducer to the inner margin of the opposite skull table.

2. Head circumference: the head circumference is imaged in the same plane as BPD. It was traced along the outer perimeter of the calvarium.

3. Abdominal circumference: It is measured in axial view of the fetal abdomen at the level of stomach and intrahepatic portion of the umbilical vein. The measurement were made along the outer edge of the abdomen.

Figure:11. Abdominal circumference in third trimester.

4. Femur length: It was measured along the long axis of the diaphysis from the greater trochanter to the lateral condyle, with both ends clearly visible. Femur closest to the abdominal wall was measured.

Figure:12. Femur length in third trimester.

The gestational age and expected date of delivery were calculated by the traditional LMP method by adding 9 months and 7 days to the first day of last menstrual period. Thereafter, the predictive gestation age was recorded with respect to each parameter and mean gestational age was calculated. Each parameter was measured in cms and gestational age in weeks, and their mean was calculated. These means were then compared with published western nomograms (Hadlock's) for each parameter. The observations collected were used to compare gestational age given by USG with gestational age calculated by the traditional LMP method

Statistical Method

The statistical analysis was perforemd by STATA 11.2 (College station Station TX USA). Descriptive statistics were perforemd by all the study variables like head circumference, Biparietal diameter, Abdominal cricumference and fermur length. Percentage of changes from present study and hadlock score or above parameters were calculated for pregnant women with gestational of 18 to 24 weeks and 28 to 34 weeks. Gestaioal age from LMP and above 4 parameters difference were calculated. And its expressed as frequency and percentage

Observations

OBSERVATIONS

Observations of table shows that the HC (58%) is the most accurate individual parameter, followed FL (46%) and BPD (40%), with AC (38%) being the least accurate individual parameter to determine gestational age from 18 to 24 weeks.

Difference: Gestation age by LMP and gestational age by USG– All 4 parameters

Table:4. 18-24 Weeks – Common table

	Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length		Ultrasound	
	No.	%	No.	%	No.	%	No.	%	No.	%
-3	1	2%								
-2			2	4%	2	4%	3	6%	1	2%
-1	7	14%	9	198 %	10	20%	8	18%	5	10%
0	29	58%	20	40%	19	38%	23	46%	28	56%
1	9	18%	14	28%	12	24%	11	22%	12	24%
2	4	8%	5	10%	5	10%	5	10%	4	8%
3					1	2%	1	2%		
4					1	2%				

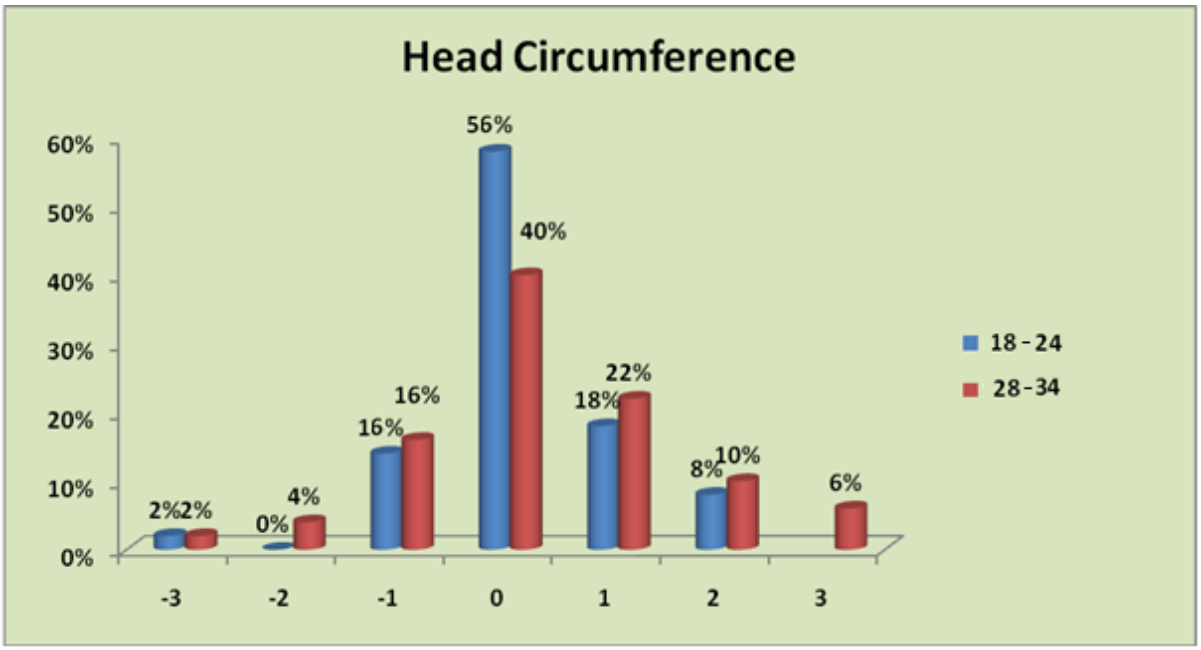
Observations of tables show that from 28 to 34 weeks (third trimester) of gestational age, the most accurate individual parameter HC (40%), followed by BPD (36%) and AC (32%) , with femur length least accurate individual parameter to determine gestational age from 28 to 34 weeks.

Table:5. 28-34 Weeks – Common table

	Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length		Ultrasound	
	No.	%	No.	%	No.	%	No.	%	No.	%
-3	1	2%			1	2%				
-2	2	4%	2	4%	1	2%	1	2%		
-1	8	16%	13	26%	2	4%	11	22%	4	8%
0	20	40%	18	36%	16	32%	15	30%	22	44%
1	11	22%	14	28%	14	28%	14	28%	18	36%
2	5	10%	3	6%	10	20%	8	16%	4	8%
3	3	6%			6	12%	1	2%	1	2%
4									1	2%

Table:6. Head Circumference

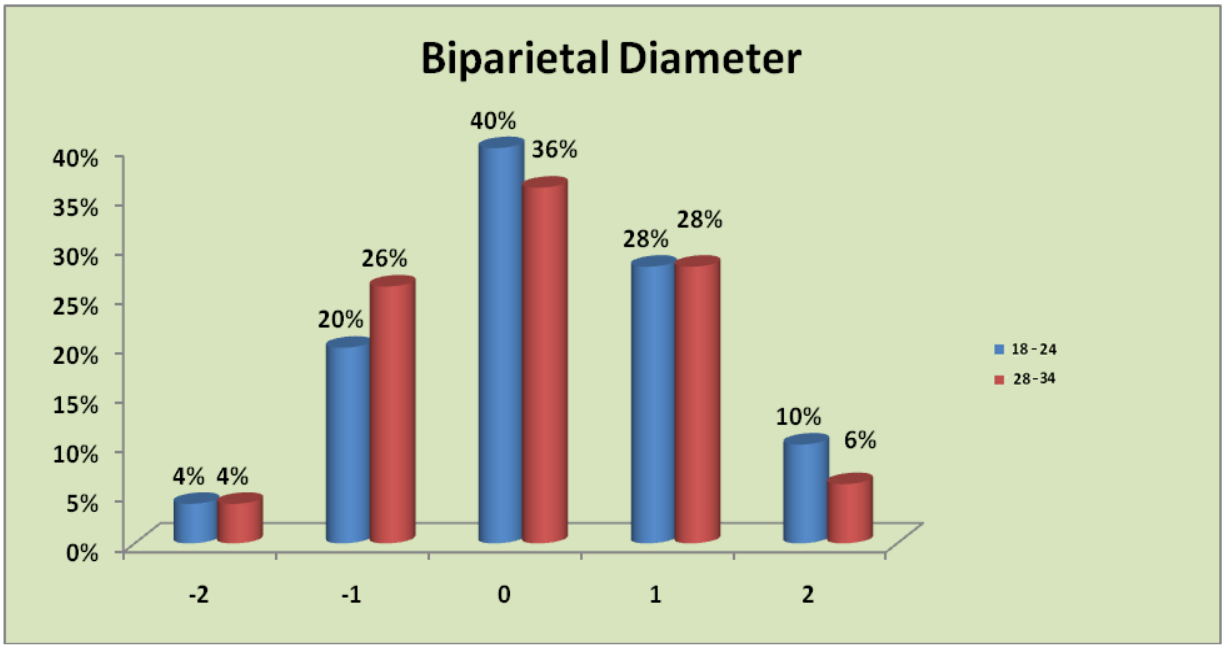
	18 to 24 weeks		28 to 34 weeks	
	Number of Cases	Percentage	Number of Cases	Percentage
-3	1	2%	1	2%
-2			2	4%
-1	7	16%	8	16%
0	29	56%	20	40%
1	9	18%	11	22%
2	4	8%	5	10%
3			3	6%



Graph:1. Head circumference difference

Table:7. Biparietal Diameter

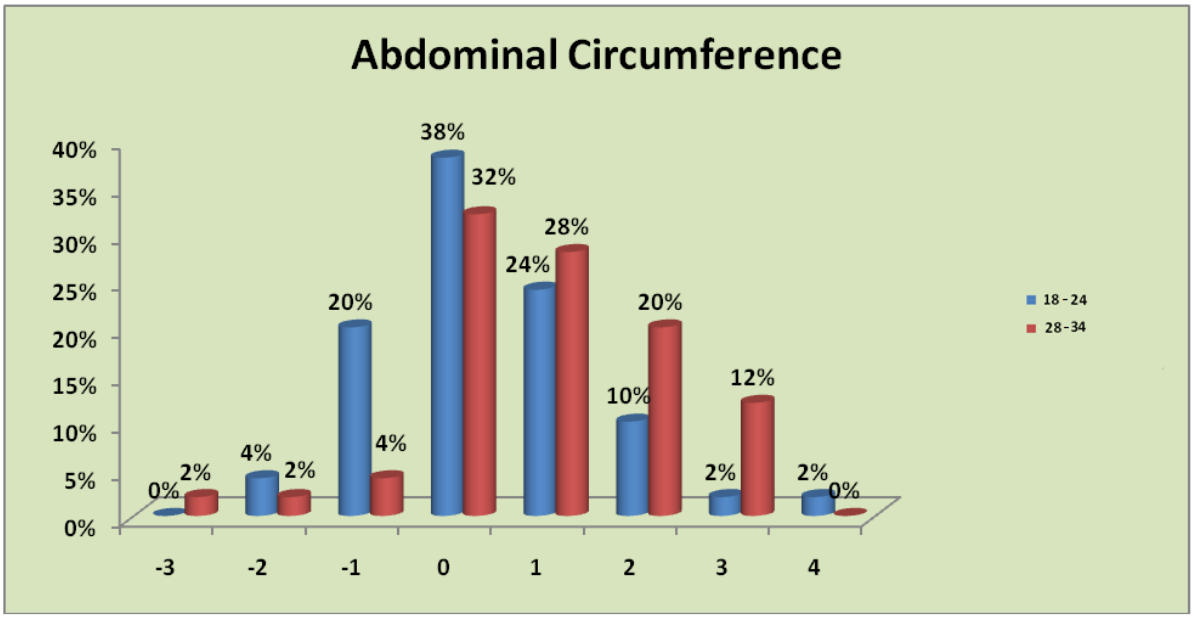
	18 to 24 weeks		28 to 34 weeks	
	Number of Cases	Percentage	Number of Cases	Percentage
-3				
-2	2	4%	2	4%
-1	9	19.8%	13	26%
0	20	40%	18	36%
1	14	28%	14	28%
2	5	10%	3	6%



Graph:2 Biparietal diameter difference.

Table:8. Abdominal Circumference

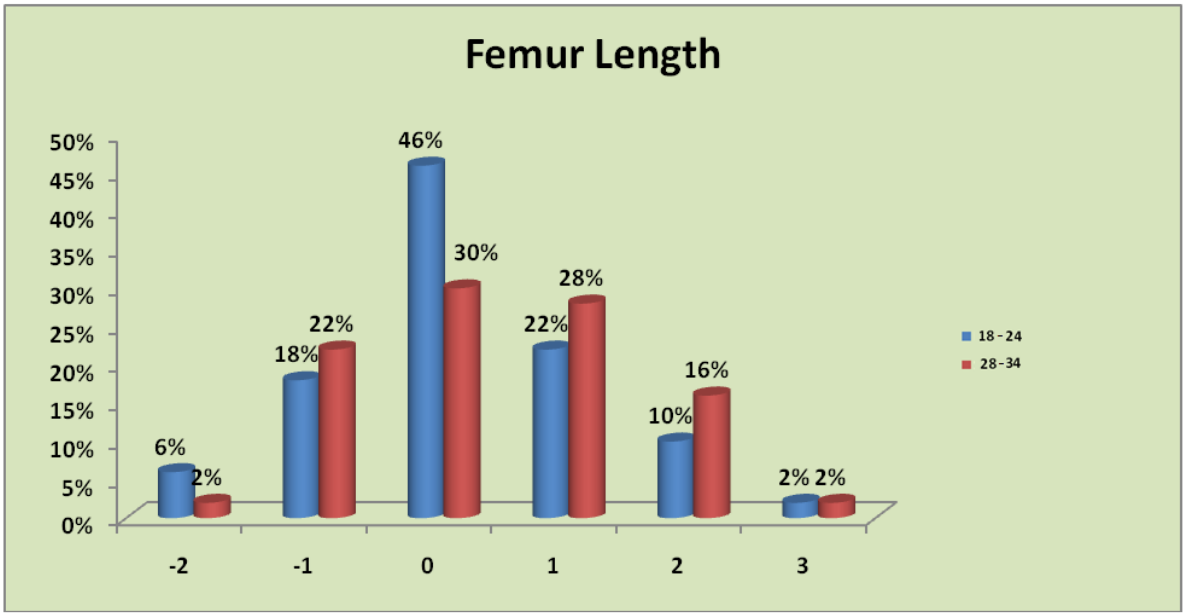
	18 to 24 weeks		28 to 34 weeks	
	Number of Cases	Percentage	Number of Cases	Percentage
-3			1	2%
-2	2	4%	1	2%
-1	10	20%	2	4%
0	19	38%	16	32%
1	12	24%	14	28%
2	5	10%	10	20%
3	1	2%	6	12%
4	1	2%		



Graph:3. Abdominal Circumference difference.

Table:9. Femur Length

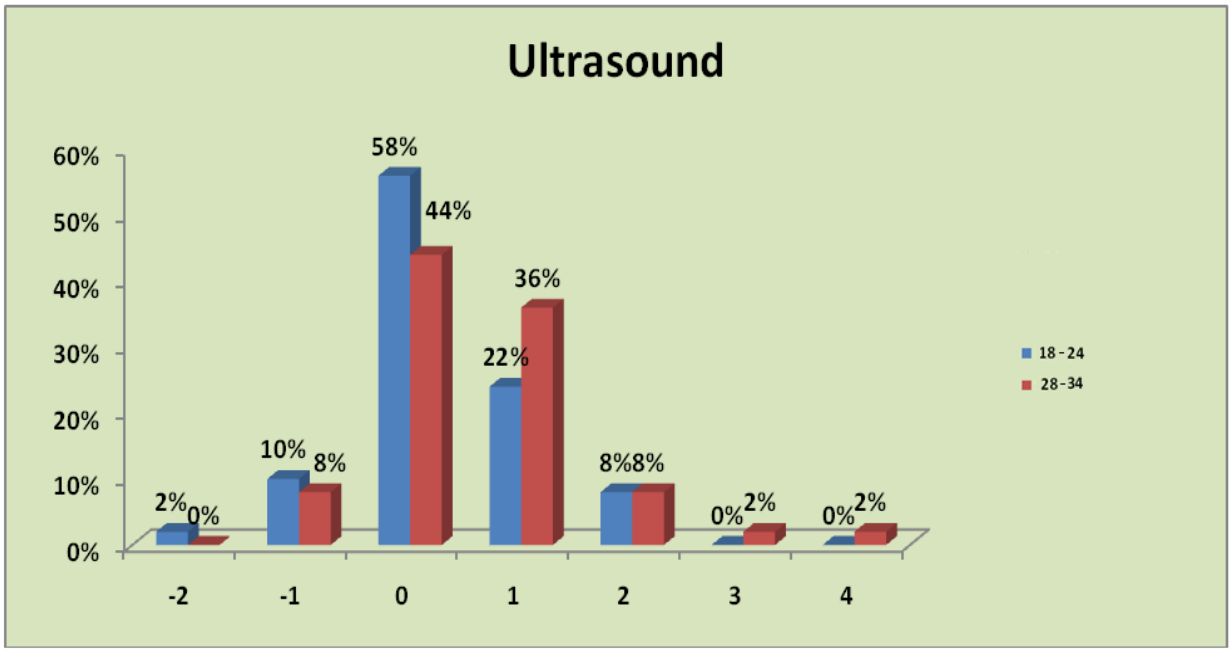
	18 to 24 weeks		28 to 34 weeks	
	Number of Cases	Percentage	Number of Cases	Percentage
-2	3	6%	1	2%
-1	8	18%	11	22%
0	23	46%	15	30%
1	11	22%	14	28%
2	5	10%	8	16%
3	1	2%	1	2%



Graph:4. Femur length difference

Table:10. Mean gestational age comparison

	18 to 24 weeks		28 to 34 weeks	
	Number of Cases	Percentage		
-2	1	2%		
-1	5	10%	4	8%
0	28	58%	22	44%
1	12	22%	18	36%
2	4	8%	4	8%
3			1	2%
4			1	2%



Graph:5. Mean gestational age difference.

Size - Comparisons of mean parameters measurement between P & H (P-Present study , H-Haldock study) – Common table

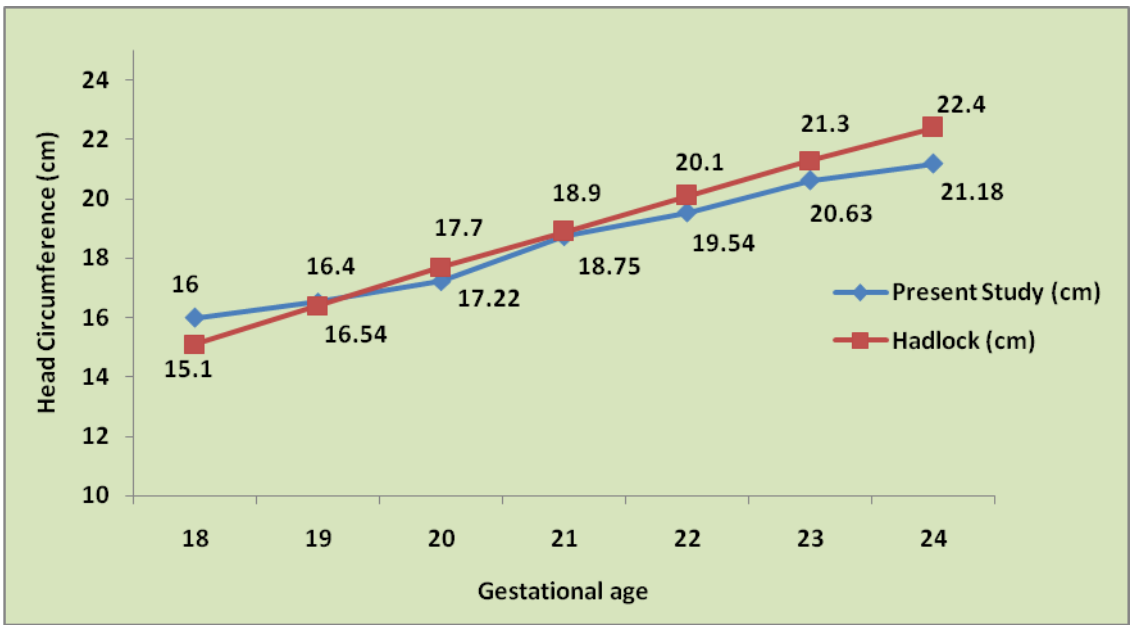
Table:11. 18 to 24 weeks

	Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length	
	P	H	P	H	P	H	P	H
18	16	15.1	4.05	3.9	12.1	12.5	2.79	2.7
19	16.54	16.4	4.34	4.3	13.84	13.7	2.92	3.0
20	17.22	17.7	4.53	4.6	14.38	15.0	3.22	3.3
21	18.75	18.9	4.95	5.0	15.98	16.2	3.45	3.5
22	19.54	20.1	5.21	5.3	16.78	17.4	3.69	3.8
23	20.63	21.3	5.38	5.6	17.33	18.5	3.91	4.1
24	21.18	22.4	5.55	5.9	17.25	19.7	3.89	4.4

P – Present Study H- Hadlock

Table:12. Head circumference

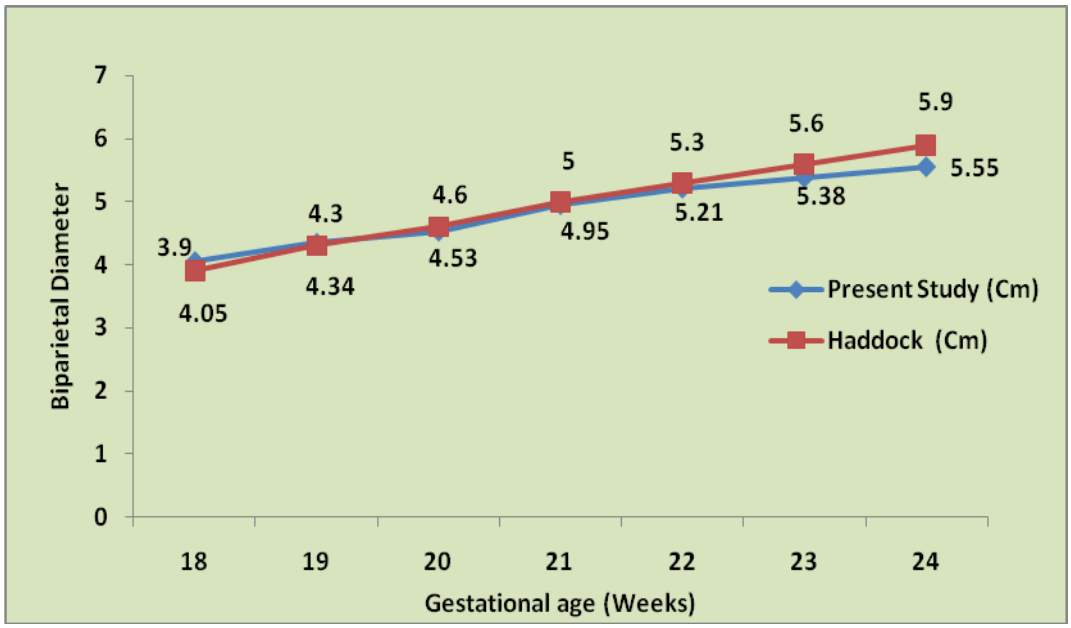
	Head Circumference		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
18	16	15.1	5.96%
19	16.54	16.4	0.85%
20	17.22	17.7	-2.71%
21	18.75	18.9	-0.79%
22	19.54	20.1	-2.79%
23	20.63	21.3	-3.15%
24	21.18	22.4	-5.45%



Graph:6. Head circumference difference in comparison with Hadlock

Table:13. Biparietal diameter

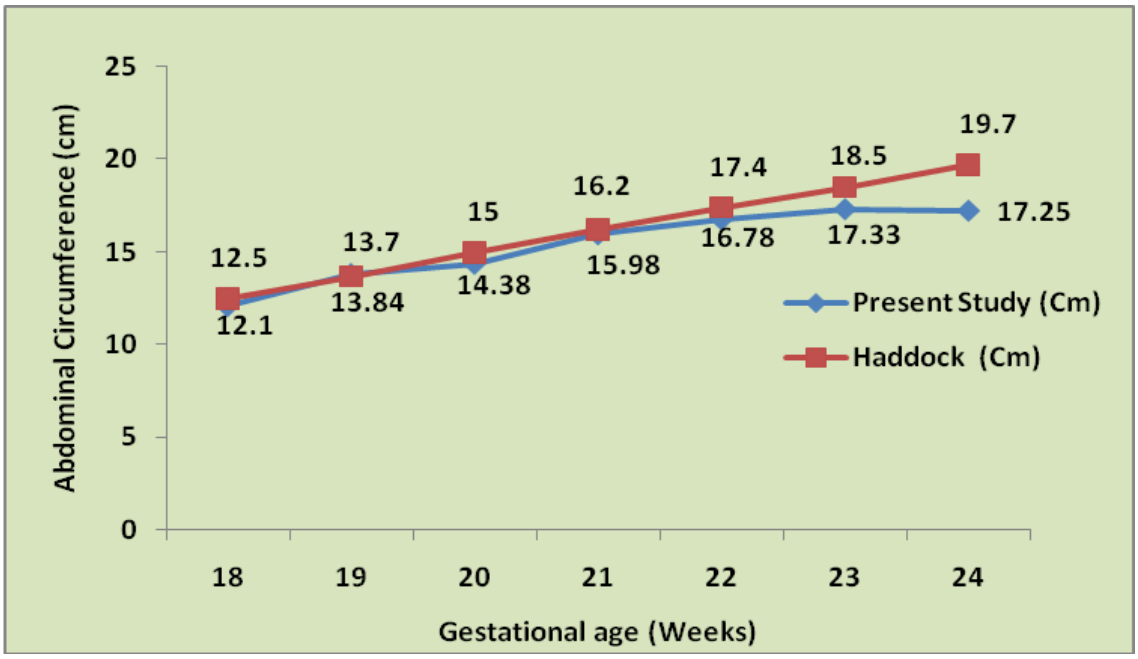
	Biparietal Diameter		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
18	4.05	3.9	3.85%
19	4.34	4.3	0.93%
20	4.53	4.6	-1.52%
21	4.95	5.0	-1.00%
22	5.21	5.3	-1.70%
23	5.38	5.6	-3.93%
24	5.55	5.9	-5.93%



Graph:7. Biparietal diameter difference in comparison with Hadlock

Table:14. Abdominal circumference

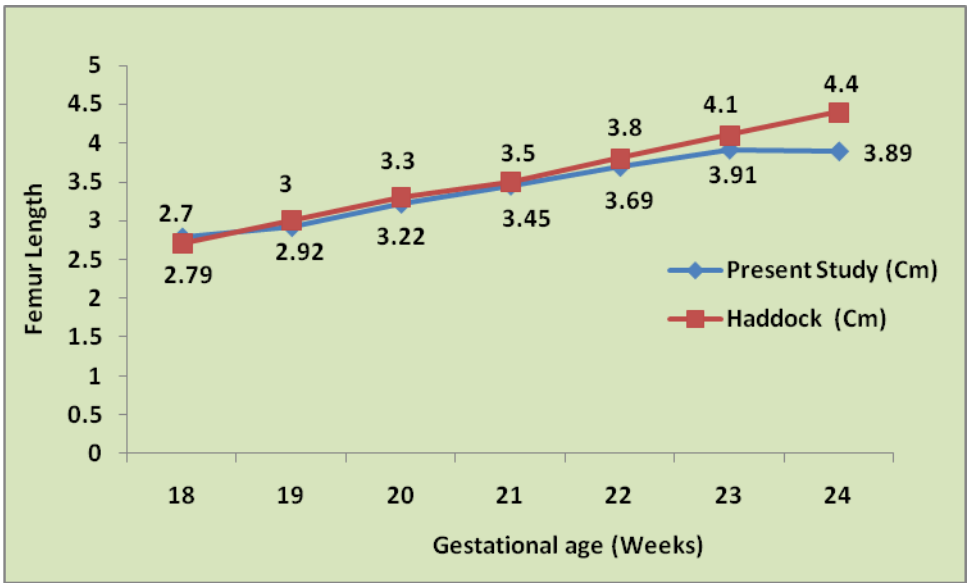
	Abdominal Circumference		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
18	12.1	12.5	-3.20%
19	13.84	13.7	1.02%
20	14.38	15.0	-4.13%
21	15.98	16.2	-1.36%
22	16.78	17.4	-3.56%
23	17.33	18.5	-6.32%
24	17.25	19.7	-12.44%



Graph:8. Abdominal circumference difference in comparison with Hadlock

Table:15. Femur length

	Femur Length		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
18	2.79	2.7	3.33%
19	2.92	3.0	-2.67%
20	3.22	3.3	-2.42%
21	3.45	3.5	-1.43%
22	3.69	3.8	-2.89%
23	3.91	4.1	-4.63%
24	3.89	4.4	-11.59%



Graph:9. Femur length difference in comparison with Hadlock

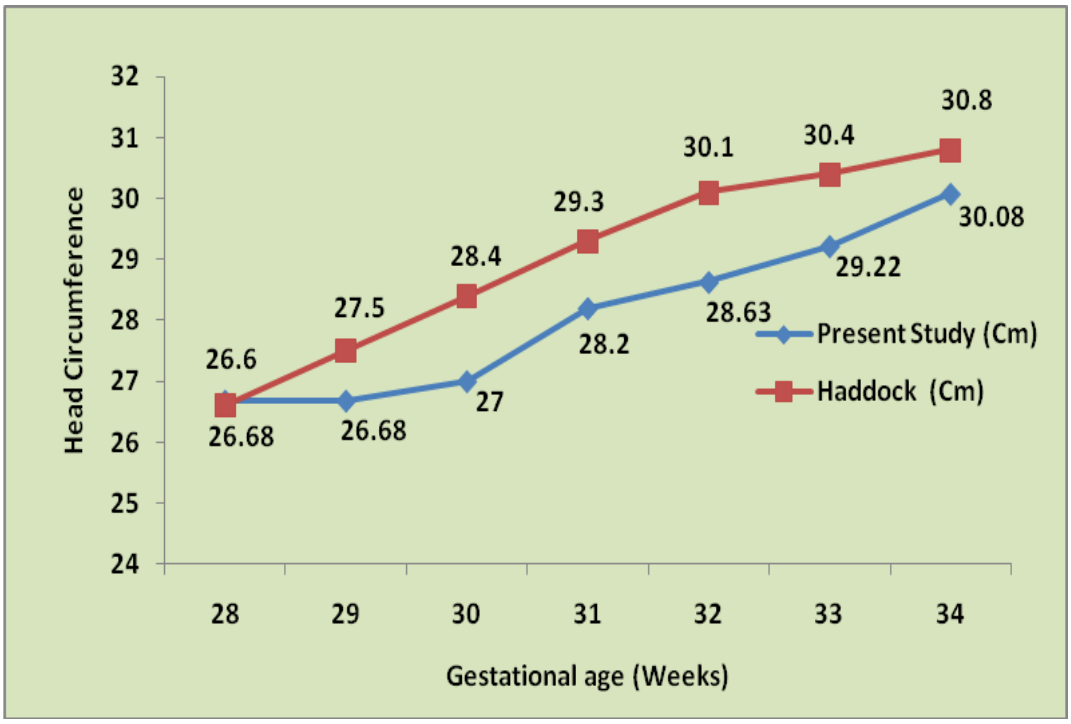
Size - Comparisons of mean parameters P & H (P-Present study , H-Haldock study) – Common table.

Table:16. 28-34 Weeks

	Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length	
	P	H	P	H	P	H	P	H
28	26.68	26.6	71.28	7.1	24.0	24.0	5.47	5.4
29	26.68	27.5	7.23	7.3	24.86	25.1	5.41	5.6
30	27.0	28.4	7.22	7.6	25.43	26.1	5.49	5.8
31	28.2	29.3	7.67	7.8	25.72	27.1	5.82	6.0
32	28.63	30.1	7.95	8.1	27.0	28.1	5.99	6.2
33	29.22	30.4	8.19	8.3	27.52	29.1	6.24	6.4
34	30.08	30.8	8.29	8.5	28.69	30.0	6.50	6.6

Table:17. Head circumference

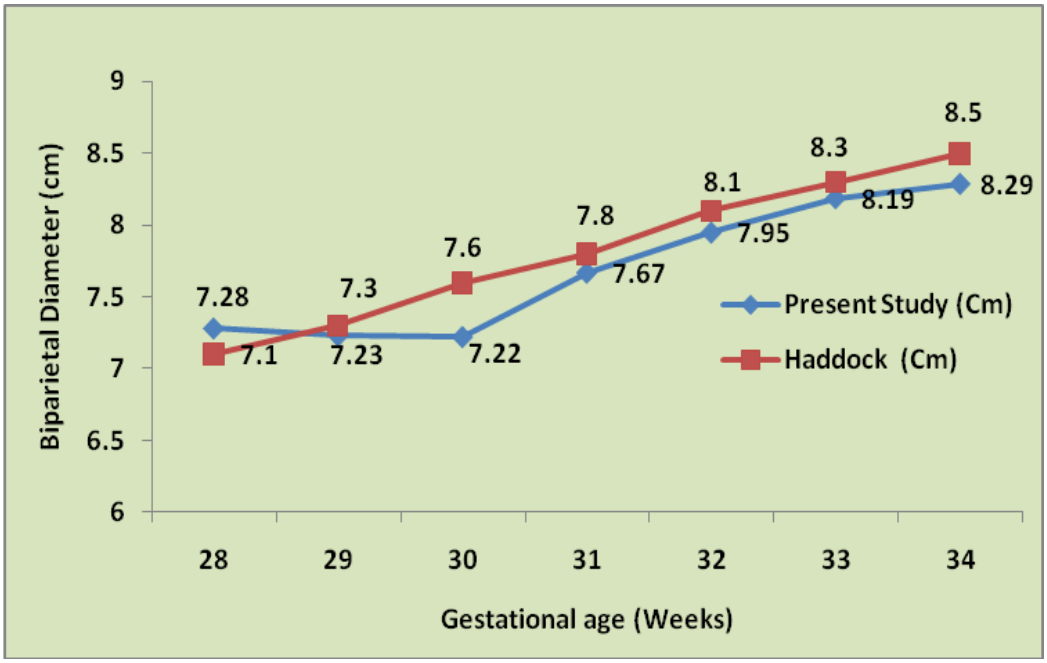
	Head Circumference		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
28	26.68	26.6	0.30%
29	26.68	27.5	-2.98%
30	27.0	28.4	-4.93%
31	28.2	29.3	-3.75%
32	28.63	30.1	-4.88%
33	29.22	30.4	-3.88%
34	30.08	30.8	-2.34%



Graph:10. Head circumference difference in comparison with Hadlock

Table:18. Biparietal diameter

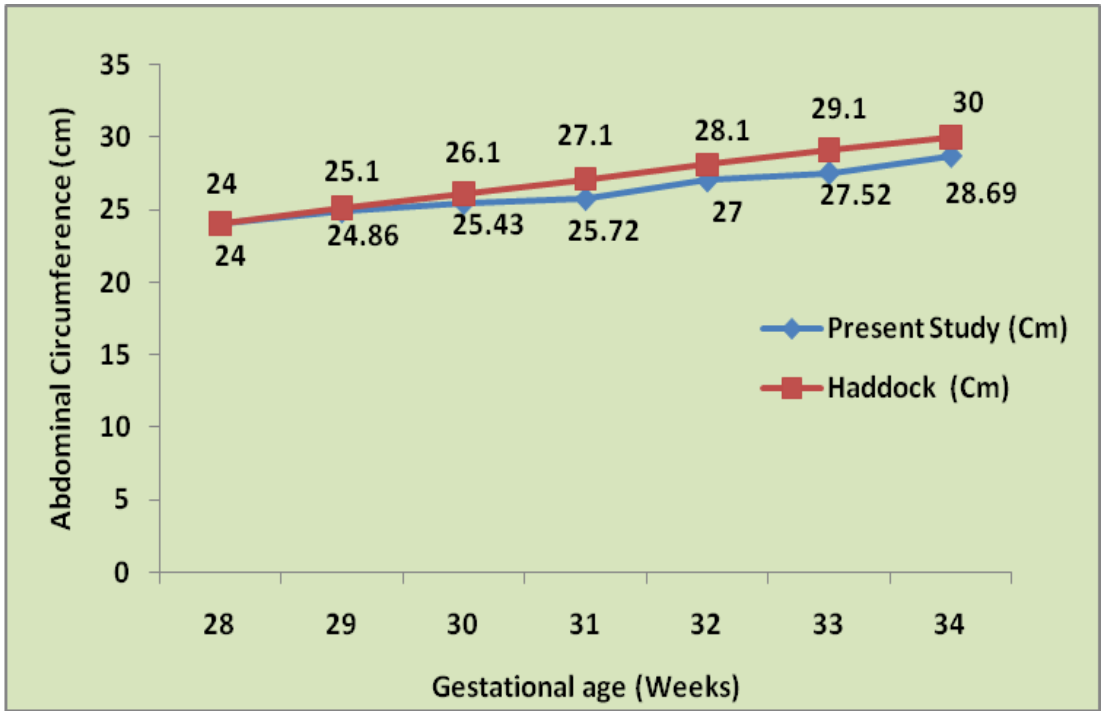
	Biparietal Diameter		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
28	7.28	7.1	2.54%
29	7.23	7.3	-0.96%
30	7.22	7.6	-5.00%
31	7.67	7.8	-1.67%
32	7.95	8.1	-1.85%
33	8.19	8.3	-1.33%
34	8.29	8.5	-2.47%



Graph:11. Biparietal diameter difference in comparison with Hadlock

Table:19. Abdominal Circumference

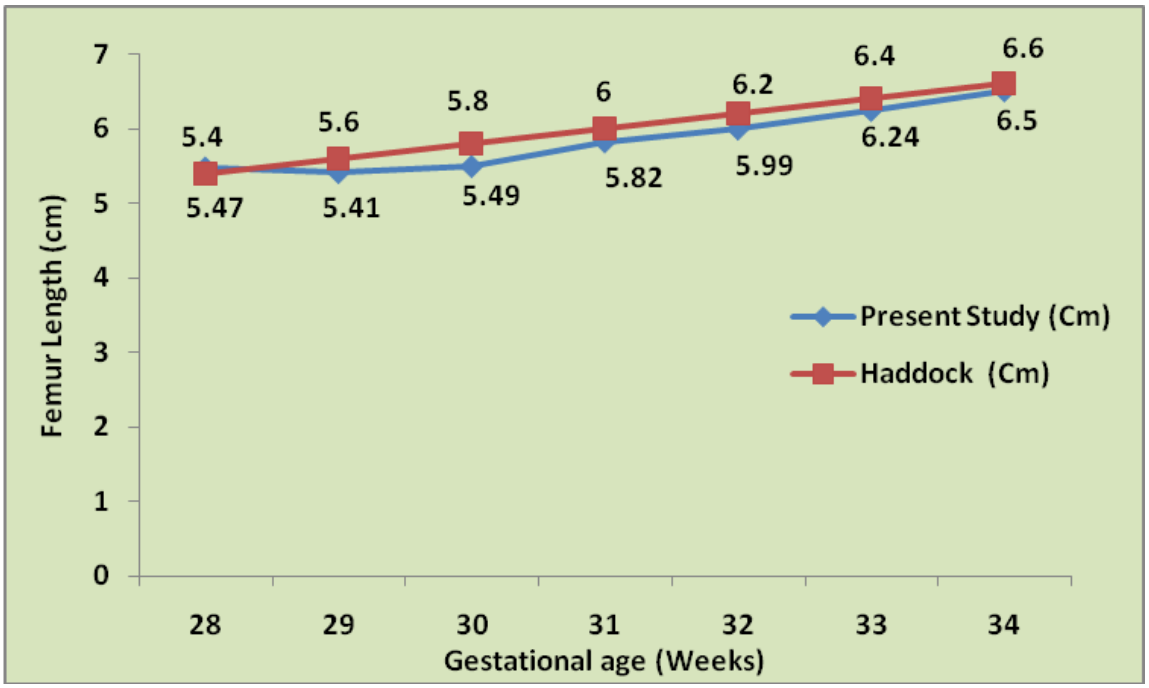
	Abdominal Circumference		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
28	24.0	24.0	0%
29	24.86	25.1	-0.96%
30	25.43	26.1	-2.57%
31	25.72	27.1	-5.09%
32	27.0	28.1	-3.91%
33	27.52	29.1	-5.43%
34	28.69	30.0	-4.37%



Graph:12. Abdominal circumference difference in comparison with Hadlock

Table:20.Femur length

	Femur Length		
	Present Study (In Cm)	Haddock (In Cm)	% of Difference
28	5.47	5.4	1.30%
29	5.41	5.6	-3.39%
30	5.49	5.8	-5.34%
31	5.82	6.0	-3.00%
32	5.99	6.2	-3.39%
33	6.24	6.4	-2.50%
34	6.50	6.6	-1.52%



Graph:13. Femur length difference in comparison with Hadlock

Tables 6 to10 show that the accuracy of each parameter is decreased as the pregnancy advances.

Variations in gestational age by all four parameters increase from -3 to + 4 weeks.

Tables and show the comparission of four fetal biometric parameters of present study with Hadlock's findings according to gestational age from 18 to 24 weeks and 28to 34 weeks.

Tables 11 to 16 show , i.e from 18 to 24 weeks gestation, the difference varies from 5.96% to – 5.45% for head circumference, from 3.85% to – 5.93% in biparietal diameter, from 1.02% to – 12.44% in abdominal circumference, from 3.33% to – 11.59% in femur length.

Table 16 to 20, i.e from 28 to 34 weeks gestation, the difference varies from 0.30% to – 4.93% for head circumference, from 2.54% to – 5.00% in biparietal diameter, from - 0.96% to – 5.43% in abdominal circumference, from 1.30% to – 5.34% in femur length.

The over all trend in both parameters show that the mean measurement of all four parameters in the present study was lower than western normograms.

Discussion

DISCUSSION

Many researchers in the past worked on the correct estimation of gestational age by measuring different biometric parameters by ultrasound. By using four parameters to determine gestational age in the present study, In our study we found that the accuracy of each parameter decreases as gestational age increases. Observations show that mean gestational is little more accurate in predicting gestational age than

These findings were supported by hadlock et al, they stated that a combination of multiple fetal parameters provided better age estimation than individual parameter. Also hohler found that the measurement of more than one fetal parameter, in a sense, prevents over reliance of any single measurement.

Hadlock et al stated that the regression equations developed from white middle class populations is applicable to the population of different socio-economic and racial characteristics. Ruvolo et al found no statistically significant difference in FL vs gestational age in a racially mixed population of blacks, Asians and Caucasians. However the sample size for each group was small and the chart used was not specified. In my study, my findings suggest that the means of all four fetal biometric parameters are lower than western normaograms .

Yeo et al conducted a study on Chinese , Malaysian and Indian population showed that fetal FL are apparently shorter than the indian FL therefore proving the existence of differences in ultrasound measurements of FL in different ethnic groups. Lai and Yeo demonstrated slightly smaller BPD, HC, AC and FL, more pronounced over the course of gestation in Asians compared to white fetuses.

Lachman and Shen conducted a study on 128 cases of Chinese fetuses and found a statistically significant difference in fetal FL between Chinese population and established normograms and the Chinese FL was shorter by 0.56 mm which ultrasonographically manifest as 0.3 week difference in gestational age determination. Thomas et al demonstrated that the use of growth curves that do not take race and gender into consideration may lead to inaccurate diagnosis of infants as small or large for gestational age.

Various studies have determined that indian fetal measurements are smaller than the Caucasian fetal measurements. Madan et al conducted a study on 1539 infnats of different races as white, Asian Indians, Chinese, Hispanic and other asain and thers at northern California.

They stated that Asian Hispanic and other babies had lower mean birth weights, shorter mean lengths and smaller mean HC than white male babies. They concluded that failure to account for ethnic differences in intrauterine growth may lead to inaccurate diagnosis of fetla growth abnormalities in infants of Asian ancestry.

Shipp et al found a significant difference in the mean variance from the the expected FL and BPD among the fetuses of women in the second trimester with respect to racial group.

Less than expected FL were noted among the fetuses of Asian mothers and more than expected FL were noted among the fetuses of black mothers compared with the femurs of fetuses of white mothers. Jeswar wt al did a cross sectional study to determine gestational age frtal HC with its two standart deviation in 200 gravid patients on north Indian population. They foud discrepancy of 1.09 – 2.39 between HC at tern in Caucasian and Indian population.

Kinare et al decribed fetal size on sonography in rural Indian population and compared it with those in europen and urban indian populations. The results showed that sonography at 18 weeks underestimated gestational age compared with the LMP date by a median of – 1.4 days. Fetal AC and BPD were markedly smaller than the western references at 18 weeks, whereas FL and HC were comparable. In late pregnancy (28 to 36 weeks), all measurements were smaller than the European references. The deficit was greatest foe AC and BPD.

In our study, we observed that there is variation of fetal biometric parameters measurements in local pregnant women when compared with measurements of exiting standard normograms (hadlock). The most accurate single parameter in evaluating gestational age is head circumference, 56% in 18 to 24 weeks of gestation and 40 % in 28 to 34 weeks of gestation. The accuracy of each parameter decreases as the pregnancy advances. We also observed that the mean gestational age is most accurate in determining gestational age in both groups.

The anatomic dimensions of fetus vary according to the race, nutritional status, build and geographic location of the origin of the parents. As the growth trend of our fetuses is slower than western fetuses, all fetal biometric parameters predict imprecise gestational age and fetal weight, more so as pregnancy advances. We still don't have our own population specific tables for determination of gestational age of our own population. Therefore, if we use western normograms for gestational age determination, there are chances of significant error in gestational age estimation and the fetus may appear small for date even when it is not.

Our study suggest that the need for construction and use of fetal biometric normograms that are specific for individual population and ethnic group to determine gestational age and EDD to enable the development of better clinical guidelines for Indian population.

Conclusion

CONCLUSION

Our study reveals the use of multiple fetal biometric parameters (BPD, HC, FL, AC) to predict the most accurate gestational age and determine EDD. Our study shows that fetal anthropometric measurements significantly differ among different population groups due to racial, genetic and ethnic factors. Thus, biometric curves of one population varies with other population and may overestimate or underestimate gestational age and EDD when used for other racial or ethnic groups.

Hence a large scale study at notional level in Indian population is required to generate population specific tables and regression equations for more precise reporting of gestational age and EDD by sonogram on basis of various fetal biometric parameters for better clinical guidelines for antepartum care and fetal growth interpretation.

Summary

SUMMARY

Sonographic evaluation of fetus is important part in obstetric care. Accurate measurement of the gestational age helps in providing better obstetric and extremely important part of modern prenatal care. Many variables effect the fetal growth such as race, ethnicity, socioeconomic status etc. Thus, each particular population or ethnic group should have their own reference values. Fetal biometric parameters are not standardized in Indian scenario, hence present study is undertaken to determine whether there is any variation.

In our study we, hundred normal singleton pregnant women i.e fifty pregnant women with gestational age between 18 to 24 weeks and fifty pregnant women with gestational age between 28 to 34 weeks with proper menstrual history and known last menstrual period with no maternal complications are subjected to ultrasound for obstetric examination.

We found that the accuracy of each parameter decreases as gestational age increases and shows significant difference in anthropometric measurements when compared with existing standards. Observations also show that mean gestational is little more accurate in predicting gestational age than individual parameter.

Hence a large scale study at notional level in Indian population is required to generate population specific tables and regression equations.

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Annexure

ANNEXURE

1. INFORMED CONSENT FORM

I _____

do here by give my informed consent for the research program as a part of M.D. Dissertation being carried out at Department of Radiology, VIMS & RC,Bangalore. I have been explained about the details of the research program in the language I understand. I have voluntarily given this informed consent for publication of data and I will not make any claims what so ever against any individual or the institution in the process of this research programme, if anything untoward happens in the process.

SIGNATURE OF THE WITNESS **SIGNATURE OF THE PATIENT**

Name & Address **Name & Address**

Master chart

Serial Number	Name	Age	Ip / Op Number	Date	Last Mentrual Period	Expected Date of Deliver based on LMP	Period of Gestation by LMP	Fetal Biometry								GESTATIONAL AGE BY ULTRASOUND
								Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length		
								Size	POG	Size	POG	Size	POG	Size	POG	
1	ABIDA	23	135328	10/10/2015	5/27/2015	3/3/2016	18W3D	16.0 CM	18W5D	4.05CM	18W2D	12.1CM	17W5D	2.79CM	18W3D	18W2D
2	SHOBA	23	3112859	4/23/2015	12/11/2014	9/20/2015	18W4D	15.6CM	18W3D	4.05CM	18W2D	13.7CM	19W0D	2.91CM	19W0D	18W4D
3	FARHEEN	27	2506424	4/15/2015	12/4/2014	9/10/2015	18W6D	15.3CM	18W1D	4.04CM	18W1D	13.3CM	18W5D	2.70CM	18W3D	18W2D
4	GEETHA	24	3259813	11/2/2015	10/2/2014	7/9/2015	18W6D	16.6CM	19W2D	4.57CM	19W5D	14.3CM	19W4D	2.86CM	18W5D	19W2D
5	POOJA	25	3726494	4/23/2015	12/12/2014	9/18/2015	18W6D	16.1CM	18W6D	4.06CM	18W2D	12.4CM	18W0D	2.68CM	18W1D	18W2D
6	VIMALA	24	3752694	4/25/2015	12/11/2014	9/17/2015	19W2D	16.8CM	19W3D	4.36CM	19W1D	14.7CM	20W0D	2.98CM	19W1D	19W3D
7	KOMALA	22	133246	10/14/2015	6/1/2015	3/7/2016	19W2D	16.5CM	19W1D	4.33CM	19W0D	12.3CM	18W0D	2.85CM	18W5D	18W5D
8	SANITHA	24	3094342	6/10/2015	5/24/2015	2/28/2016	19W2D	17.6CM	20W3D	4.8CM	20W3D	13.9CM	19W1D	3.18CM	19W6D	20W0D
9	PREETHI	26	3666471	4/8/2015	11/23/2014	8/30/2015	19W3D	17.5CM	20W0D	4.47CM	19W1D	15.2CM	20W3D	3.06CM	19W3D	19W5D
10	NEHA	27	3694114	4/26/2015	12/11/2014	9/17/2015	19W3D	16.9CM	19W3D	4.39CM	19W1D	14.8CM	20W0D	3.02CM	19W2D	19W3D
11	PADMINI	24	3445188	5/8/2015	12/21/2014	9/27/2015	19W5D	18.0CM	20W3D	4.77CM	20W2D	14.6CM	19W6D	3.40CM	20W4D	20W2D
12	PRIYANKA	27	3794914	4/9/2015	11/22/2014	8/29/2015	19W5D	17.0CM	19W4D	4.59CM	19W5D	15.5CM	20W4D	3.18CM	19W6D	20W0D
13	SRINIDHI	27	3702247	2/13/2015	9/28/2014	7/5/2015	19W5D	16.5CM	19W1D	4.39CM	19W1D	14.1CM	19W3D	3.0CM	19W1D	19W1D
14	SHOBA	22	2761575	4/24/2015	12/6/2014	9/12/2015	19W6D	16.9CM	19W3D	4.32CM	19W0D	12.3CM	18W0D	3.17CM	19W6D	19W1D
15	PRAMILA	25	141327	2/11/2105	9/25/2014	7/2/2015	19W6D	16.9CM	19W3D	4.41CM	19W2D	14.5CM	19W5D	3.40CM	20W4D	19W5D
16	DEEPTHI	25	4123134	10/15/2015	5/28/2014	3/3/2016	20W0D	17.3CM	19W6D	4.54CM	19W5D	14.4CM	19W4D	3.17CM	19W6D	19W5D
17	ANITHA	26	4188110	10/12/2015	5/25/2015	2/28/2016	20W1D	17.2CM	19W5D	4.55CM	19W5D	13.0CM	18W3D	3.12CM	19W4D	19W2D
18	SARITHA	22	3715957	4/17/2015	11/25/2014	9/1/2015	20W3D	18.0CM	20W2D	4.75CM	20W2D	16.3CM	21W2D	3.32CM	20W2D	20W3D
19	SONIYA	20	3888220	5/8/2015	12/16/2014	9/22/2015	20W3D	16.7CM	19W2D	4.31CM	19W0D	14.4CM	19W5D	3.07CM	19W3D	19W2D
20	VIJAYLAKSHMI	28	3995263	10/8/2015	5/18/2015	2/22/2016	20W3D	17.7CM	20W1D	4.66CM	20W0D	14.7CM	20W0D	3.33CM	20W2D	20W1D
21	RANI	26	110925	10/16/2015	5/25/2015	2/29/2016	20W4D	17.9CM	20W2D	5.05CM	21W2D	14.7CM	20W0D	3.28CM	20W1D	20W3D
22	RAJASHREE	21	3879428	5/5/2015	12/12/2014	9/18/2015	20W4D	15.8CM	18W4D	4.25CM	18W5D	12.9CM	18W3D	2.81CM	18W4D	18W4D
23	VIDYA	27	3148106	5/12/2015	12/18/2014	9/24/2015	20W5D	19.2CM	21W3D	5.17CM	21W4D	15.3CM	20W3D	3.45CM	20W6D	21W0D
24	ASHA	26	151254	10/5/2015	5/13/2015	2/17/2016	20W5D	21.2CM	23W2D	5.41CM	22W3D	17.9CM	22W5D	3.86CM	22W2D	22W5D
25	DHANUNJAY	25	3893077	9/30/2015	5/28/2015	2/21/2016	20W6D	18.5CM	20W5D	4.89CM	20W5D	16.5CM	21W3D	3.39CM	20W4D	20W6D
26	SHOBA	28	3729345	10/5/2015	5/12/2015	2/16/2016	20W6D	18.4CM	20W5D	4.89CM	20W5D	15.8CM	20W6D	3.33CM	20W2D	20W4D
27	KALEDA	28	143134	10/8/2015	5/14/2015	2/18/2016	21W0D	19.9CM	20W2D	4.68CM	20W1D	15.9CM	21W0D	3.58CM	21W2D	20W5D
28	POONAM	27	3959259	10/10/2015	5/15/2015	2/19/2016	21W1D	17.0CM	19W4D	4.48CM	19W3D	13.9CM	19W1D	3.04CM	19W2D	19W2D
29	LAKSHMI DEVI	20	3435841	4/7/2014	11/8/2014	8/15/2015	21W3D	19.9CM	22W0D	5.13CM	21W3D	17.8CM	22W5D	4.12CM	23W2D	22W2D
30	SUSHMITHA	24	3448103	5/21/2015	12/22/2014	9/28/2015	21W3D	19.3CM	21W3D	4.83CM	20W4D	16.9CM	21W6D	3.58CM	21W2D	21W2D
31	NAGAVATHI	24	3864167	4/22/2015	11/20/2014	8/27/2015	21W6D	19.4CM	21W4D	5.16CM	21W4D	15.9CM	21W0D	3.72CM	21W6D	21W3D
32	POOJA	26	139867	10/19/2015	5/23/2015	2/27/2016	21W2D	19.2CM	21W2D	5.69CM	23W2D	18.2CM	23W0D	3.70CM	21W5D	22W2D
33	DIVYA	22	3681715	4/28/2015	11/28/2014	9/4/2015	21W4D	19.3CM	21W3D	4.97CM	21W0D	15.9CM	21W0D	3.65CM	21W4D	21W1D
34	VANITHA	26	3835641	4/10/2015	11/9/2014	8/16/2015	21W5D	19.6CM	21W5D	5.11CM	21W3D	17.4CM	22W2D	3.61CM	21W3D	21W5D
35	ASHA	25	3770086	4/17/2015	11/16/2014	8/23/2015	21W5D	19.4CM	21W4D	5.05CM	21W2D	16.9CM	21W6D	3.86CM	22W2D	21W5D
36	USHA	26	144100	2/2/2015	8/31/2014	6/7/2015	22W1D	19.5CM	21W5D	4.98CM	21W0D	16.5CM	21W3D	3.2CM	20W1D	21W0D
37	NAVYA	23	3156736	10/17/2015	5/15/2015	2/19/2016	22W1D	18.3CM	20W4D	4.84CM	20W4D	15.0CM	20W1D	3.26CM	20W1D	20W2D
38	SWETHA	27	3569487	4/20/2015	11/15/2014	8/22/2015	22W2D	20.5CM	22W4D	5.28CM	22W0D	17.0CM	22W0D	3.89CM	22W3D	22W1D
39	FARAKHAN	28	3771610	4/24/2015	11/19/2014	8/26/2015	22W2D	20.2CM	22W2D	5.13CM	21W3D	18.0CM	22W5D	4.13CM	23W2D	22W3D
40	SELVI	29	3616591	12/1/2015	9/8/2014	15-Jun	22W2D	19.0CM	21W1D	5.42CM	22W5D	16.6CM	21W4D	3.5CM	21W1D	21W4D
41	PRIYA	22	3722869	2/9/2015	9/5/2014	6/12/2015	22W3D	19.1CM	21W2D	5.59CM	23W0D	17.9CM	22W5D	3.86CM	22W2D	22W2D
42	SUCHMITHA	20	105736	10/15/2015	5/11/2015	2/15/2016	22W3D	19.0CM	21W1D	5.17CM	21W4D	16.4CM	21W3D	3.61CM	21W3D	21W2D
43	REVATHI	27	3763765	2/13/2015	9/9/2015	6/16/2015	22W3D	21.2CM	23W2D	5.72CM	23W3D	17.9CM	22W5D	4.05CM	23W0D	23W0D
44	BHAGYA	23	132331	9/30/2015	4/24/2015	1/28/2016	22W6D	19.4CM	21W4D	5.06CM	21W2D	16.9CM	21W6D	3.69CM	21W5D	21W4D
45	RAMYA	21	3501925	2/7/2015	8/29/2014	6/5/2015	23W1D	21.1CM	23W1D	5.46CM	22W4D	18.2CM	23W0D	3.86CM	22W2D	22W5D
46	NAGAMMA	22	3831578	4/11/2015	10/30/2014	8/6/2015	23W2D	21.4CM	23W3D	5.64CM	23W1D	16.9CM	21W6D	4.18CM	23W6D	23W2D
47	SUBASHREE	25	3804398	5/25/2015	12/11/2014	9/17/2015	23W4D	21.7CM	23W5D	5.63CM	23W1D	19.5CM	24W1D	4.40CM	24W3D	23W6D
48	SHANTA	22	4185921	10/6/2015	4/24/2015	1/29/2016	23W4D	22.4CM	24W3D	5.81CM	23W5D	14.2CM	19W3D	3.79CM	22W0D	22W2D
49	NETHRAVTHI	21	3722995	2/9/2015	8/27/2014	6/3/2015	23W5D	19.2CM	21W2D	5.30CM	22W0D	15.9CM	21W0D	3.52CM	21W0D	21W2D
50	SUBHASHINI	27	3543762	4/24/2015	11/9/2014	8/16/2015	23W5D	21.4CM	23W3D	5.46CM	22W4D	19.4CM	24W0D	3.86CM	22W2D	23W2D

Serial Number	Name	Age	Ip / Op Number	Date	Last Mentrual Period	Expected Date of Deliver based on LMP	Period of Gestation by LMP	Fetal Biometry								
								Head Circumference		Biparietal Diameter		Abdominal Circumference		Femur Length		Gestational age by ultrasound
								Size	POG	Size	POG	Size	POG	Size	POG	
1	DIVYA	27	92854	10/17/2015	3/30/2015	1/4/2016	28W5D	26.5CM	28W5D	7.15CM	28W5D	24.4CM	28W4D	5.49CM	29W0D	28W5D
2	RUKMINI	23	3456423	2/3/2015	7/21/2014	4/27/2015	28W1D	26.4CM	28W5D	7.05CM	28W2D	24.1CM	28W2D	5.47CM	28W6D	28W3D
3	LAKSHMI	25	3448679	5/16/2015	10/25/2014	8/1/2015	28W5D	26.1CM	28W2D	7.2CM	29W0D	24.4CM	28W4D	5.09CM	27W1D	28W0D
4	SUMALATHA	23	3421873	10/5/2015	3/21/2015	12/26/2015	28W2D	26.7CM	29W1D	7.1CM	28W5D	22.9CM	27W1D	5.3CM	28W2D	28W2D
5	RAMYA	29	3527853	1/22/2015	7/8/2014	4/14/2015	28W2D	25.6CM	27W6D	7.19CM	28W5D	24.2CM	28W3D	5.53CM	29W1D	28W3D
6	SHEAVANI	23	173719	10/14/2015	3/25/2015	12/30/2015	29W0D	25.1CM	27W1D	6.91CM	27W5D	22.9CM	27W1D	5.25CM	28W0D	27W3D
7	RADHA	28	32614	5/10/2015	3/14/2015	12/19/2015	29W2D	29.0CM	31W6D	7.65CM	30W4D	27.8CM	31W6D	5.81CM	30W2D	31W1D
8	SUMA	27	312786	4/17/2015	9/15/2014	6/22/2015	30W4D	27.0CM	30W2D	7.7CM	30W0D	24.8CM	29W0D	5.5CM	29W0D	29W5D
9	RANI	19	321856	4/16/2015	9/13/2014	7/7/2015	28W2D	28.0CM	30W5D	7.4CM	30W0D	24.8CM	29W1D	5.6CM	29W3D	29W5D
10	NAGARATHANAMMA	26	230539	2/19/2015	7/25/2014	5/1/2015	29W6D	26.9CM	29W2D	7.16CM	28W5D	24.8CM	29W0D	5.27CM	28W0D	28W5D
11	MANJULA	27	135653	4/28/2015	9/28/2014	7/5/2015	30W2D	27.3CM	29W5D	7.2CM	29W1D	26.4CM	30W3D	5.7CM	30W0D	29W5D
12	INDIRA	26	3145673	7/4/2015	5/9/2014	12/6/2015	30W4D	28.8CM	31W4D	7.6CM	30W6D	26.5CM	30W4D	5.9CM	31W0D	31W0D
13	GAYATHRI	25	564809	5/16/2015	10/13/2014	7/20/2015	30W5D	28.1CM	30W5D	7.4CM	29W5D	25.4CM	29W4D	6.0CM	31W1D	30W2D
14	MALASHREE	27	4197842	10/15/2015	3/14/2015	12/19/2015	30W5D	27.4CM	29W6D	7.48CM	30W0D	24.9CM	29W1D	5.72CM	30W0D	29W5D
15	SUMALATHA	20	3458639	1/15/2015	6/10/2014	3/17/2015	31W0D	27.0CM	29W2D	7.6CM	30W3D	25.7CM	29W6D	5.8CM	30W2D	30W0D
16	JABA	28	152331	10/13/2015	3/10/2015	12/15/2015	31W0D	28.8CM	31W4D	7.92CM	31W5D	27.3CM	31W2D	6.12CM	31W5D	31W4D
17	SHANTA	21	3156378	1/6/2015	6/8/2014	3/15/2015	30W2D	26.8CM	29W1D	7.3CM	29W2D	25.1CM	29W2D	5.5CM	29W0D	29W1D
18	MANJULA	29	110031	2/3/2015	6/30/2014	4/6/2015	31W1D	28.2CM	30W6D	7.65CM	30W4D	23.7CM	28W0D	5.72CM	30W0D	29W6D
19	SHOBA	21	345013	1/22/2015	6/18/2014	3/25/2015	31W1D	28.6CM	31W2D	7.7CM	31W1D	25.5CM	29W4D	5.6CM	29W5D	30W3D
20	HARSHA	23	3124562	1/10/2015	6/5/2014	3/12/2015	31W2D	29.9CM	33W0D	7.98CM	32W0D	27.7CM	31W5D	6.01CM	31W1D	32W0D
21	MANISHA	21	122313	10/6/2015	2/27/2015	12/4/2015	31W4D	27.7CM	31W3D	7.87CM	31W3D	28.1CM	32W0D	6.22CM	32W1D	31W3D
22	LAVANYA	27	4846406	10/8/2015	3/1/2015	12/6/2015	31W4D	28.3CM	31W0D	7.82CM	31W2D	27.5CM	31W4D	5.92CM	30W6D	31W1D
23	KAVYA	20	3666155	1/9/2015	5/31/2014	3/7/2015	31W6D	29.1CM	32W0D	8.1CM	32W5D	26.6CM	30W5D	5.8CM	30W3D	31W3D
24	JOLY	21	142608	10/12/2015	3/2/2015	12/7/2015	32W0D	30.1CM	33W2D	8.43CM	33W3D	26.9CM	31W0D	6.09CM	31W4D	32W2D
25	ASHA	26	210139	4/12/2015	8/30/2014	6/6/2015	32W1D	27.2CM	29W4D	7.4CM	29W5D	25.0CM	29W1D	5.7CM	30W0D	29W4D
26	SRAANI	22	14423	6/10/2015	2/23/2015	11/30/2015	32W1D	29.0CM	31W6D	7.96CM	32W0D	28.4CM	32W2D	6.45CM	33W2D	32W2D
27	RUMA	24	155619	10/5/2015	2/21/2015	11/28/2005	32W2D	28.5CM	31W1D	7.83CM	31W2D	26.2CM	30W2D	5.86CM	30W4D	30W5D
28	LEELAVATHI	28	130772	2/13/2015	7/2/2014	4/8/2015	32W2D	29.1CM	32W0D	8.17CM	32W5D	27.3CM	31W2D	5,94CM	31W0D	31W5D
29	DEEPIKA	27	3126754	2/4/2015	6/21/2014	3/28/2015	32W4D	27.1CM	29W3D	8.5CM	34W3D	30.7CM	34W4D	6.6CM	34W0D	33W0D
30	DIVYA	21	3668310	1/9/2015	5/26/2014	3/2/2015	32W4D	29.5CM	32W4D	8.2CM	33W2D	21.6CM	31W4D	6.0CM	31W1D	32W1D
31	REVATHI	23	3624905	2/14/2015	6/30/2014	4/6/2015	32W5D	28.5CM	31W1D	7.9CM	32W0D	26.5CM	30W4D	6.2CM	32W3D	31W3D
32	SAMEERA	22	3124987	2/20/2015	7/6/2014	4/12/2015	32W5D	28.4CM	31W1D	8.0CM	32W2D	27.2CM	31W1D	6.1CM	32W0D	31W4D
33	NEHA	23	3585944	1/16/2015	6/1/2014	3/8/2015	32W5D	28.1CM	30W5D	8.3CM	33W5D	28.7CM	32W4D	6.2CM	32W3D	32W2D
34	DEEPA	25	103649	1/29/2015	6/14/2014	3/21/2015	32W5D	29.4CM	32W3D	8.2CM	33W2D	28.7CM	32W4D	5.7CM	30W2D	32W1D
35	NIRMALA	20	3727313	2/9/2015	6/23/2014	3/30/2015	33W0D	29.8CM	33W0D	8.0CM	32W1D	27.7CM	31W5D	6.5CM	33W3D	32W4D
36	ROJA	20	503543	1/27/2015	6/10/2014	3/17/2015	33W0D	29.5CM	32W4D	7.9CM	31W5D	27.3CM	31W2D	6.2CM	32W3D	32W0D
37	KALAVATHI	24	3126785	1/19/2015	6/1/2014	3/8/2015	33W1D	30.3CM	33W5D	8.5CM	34W2D	27.0CM	31W0D	6.6CM	34W0D	33W2D
38	SUNITHA	24	144033	4/17/2015	8/28/2014	6/4/2015	33W1D	30.5CM	34W1D	8.1CM	32W5D	28.4CM	32W2D	6.3CM	33W0D	33W0D
39	PRIYANKA	22	141040	10/13/2015	2/23/2015	11/30/2015	33W1D	28.7CM	31W3D	8.56CM	34W3D	26.4CM	30W3D	5.88CM	30W4D	31W5D
40	RAMANAMMA	20	3435505	1/6/2015	5/19/2014	2/23/2015	33W1D	29.5CM	32W4D	8.0CM	32W3D	26.3CM	30W3D	6.2CM	32W2D	32W0D
41	SAJEENA	25	234008	10/3/2015	2/11/2015	11/18/2015	33W3D	29.7CM	32W5D	8.32CM	33W3D	28.9CM	33W0D	5.99CM	31W1D	32W4D
42	KUMARI	25	3571148	5/4/2015	9/12/2014	6/19/2015	33W3D	30.1CM	33W2D	8.2CM	33W0D	30.0CM	34W0D	6.9CM	35w3d	34w0d
43	NEETHA	21	234614	2/17/2015	6/27/2014	4/3/2015	33W4D	28.1CM	30W5D	7.7CM	31W1D	28.1CM	32W1D	6.4CM	33W0D	31W5D
44	KAYA	27	215000	10/18/2015	2/24/2015	12/1/2015	33W5D	30.2CM	33W3D	8.43CM	34W0D	29.8CM	33W5D	6.54CM	33W4D	33W4D
45	HEMALATHA	21	105040	10/6/2015	2/12/2015	11/19/2015	33W5D	31.1CM	34W5D	8.62CM	34W5D	30.2CM	34W1D	6.66CM	34W2D	34W3D
46	RAJALAKSHMI	29	312875	2/20/2015	6/28/2014	4/4/2015	33W6D	30.8CM	34W2D	8.5CM	34W3D	27.5CM	31W4D	6.5CM	33W3D	33W3D
47	VANAJA	27	3165340	2/5/2015	6/13/2014	3/20/2015	33W6D	29.7CM	32W5D	7.8CM	31W3D	27.2CM	31W1D	6.3CM	32W4D	32W0D
48	SOWMYA	24	236578	5/11/2015	9/15/2014	6/22/2015	34W0D	30.1CM	33W3D	8.4CM	34W0D	29.3CM	33W1D	6.6CM	34W2D	33W4D
49	CHANNAMA	29	234789	2/16/2015	6/21/2014	3/28/2015	34W0D	30.4CM	33W6D	8.5CM	34W4D	29.0CM	33W0D	6.5CM	33W5D	33W5D
50	SOWJANYA	22	3428960	10/12/2015	2/18/2015	11/25/2015	34W0D	30.2CM	33W3D	8.43CM	34W0D	28.4CM	32W2D	6.5CM	33W5D	33W2D