

## To Determine Accuracy And Reliability Of Ultrasonographic Measurements And To Demonstrate Correlation Of Parameters With Each Other

Bhusari P A\*, Chormunge P V B, Kamkhedkar S G, DiwanC V

### Abstract

*Usefulness of ultrasonography as an index for the measurement of gestational age is beyond doubt. In the First trimester – Gestational Sac Diameter (GSD), Crown Rump Length (CRL) and in Second trimester – Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) & Femur Length (FL) are the parameters used.*

*The present study aims at deriving normal values of fetal growth Parameters, in order to determine correct gestational age, to demonstrate the correlation of parameters with each other, to derive regression equation for each parameter and to compare the study with other studies carried out on aborted fetuses taking actual measurements. The study was carried out on 700 pregnant women and ultrasonic equipment used was “Real Time Ultrasonography “ All the parameters show linear growth as gestational age advances, they are strongly correlated with each other. The present study is comparable to other studies carried out on aborted fetuses taking actual measurements. Thus accuracy and reliability of ultrasonographic measurements is established.*

**Key Words:** Fetal Growth Parameters, Gestational Age, Ultrasonography, Aborted Fetuses Measurements.

### Introduction

Every Individual spends the first nine months of its Life within the womb of the mother. During this period it develops from a small single cell to an organism having billions of cells. First two months, we call the developing individual an embryo, from the third month until birth we call it a fetus.<sup>[1]</sup>

Ultrasound is the name given to high frequency sound waves over 20,000 cycles per second (20 KHz). These ultrasonographic waves are produced from a transducer & travel through human tissues at a velocity of 1500 meter per second.<sup>[2][3]</sup>

In the first trimester- the gestational sac & the embryo are the two major structures to be identified. According to Hadlock F.P., various parameters used in 2<sup>nd</sup> & 3<sup>rd</sup> trimesters are Biparietal diameter (BPD), Head

circumference (HC), Abdominal circumference (AC) & Femur Length (FL).<sup>[4]</sup> The present study aims at deriving normal values of fetal growth parameters, in order to determine correct gestational age and to compare the study with other studies carried out on aborted fetuses taking actual measurements.

### Aims and Objectives

- 1) To present a data collected by ultrasonographic parameters.
- 2) To observe the mean growth rate pattern of the fetus.
- 3) To demonstrate the correlation of parameters with each other.
- 4) To derive regression equation for each parameter.
- 5) To compare the results of the previous studies where actual measurements of the aborted fetuses of various gestational age were taken.

### Material and Methods

This project was carried out on normal pregnant females in I<sup>st</sup>, II<sup>nd</sup> & III<sup>rd</sup> trimesters. They were studied

\* Assist Prof Dept of Anatomy, NDMVPS Medical College, Nashik

#### Address for correspondence:

Dr.Bhusari Prashant Amanrao, NDMVPS Medical College, Adgaon. Nashik.03.

Email: drprashantbhusari@rediffmail

by ultrasonography for estimation of gestational age of the fetus.

Multiple parameters like GSD&CRL in the first trimester<sup>[5]</sup> and BPD, HC, AC&FL in II<sup>nd</sup> & III<sup>rd</sup> are used.

The study was carried out on 700 pregnant women, having 18-34 years of age. All patients had an uncomplicated obstetric history & an accurate knowledge of the last menstrual period.<sup>[6]</sup>

While carrying out this study ultrasonic equipment used was “Real Time Ultrasonography” with linear array sector transducer. The information so collected was recoded in proforma.

The data collected is thus subjected to the following statistical tests-Mean (average), Standard deviation, Coefficient of Variation (C.V.), Correlation Coefficient, Regression line & the Value of probability (P).

**Observation**

Using the methods described earlier made the observations. The data so collected was tabulated

Table 1: Showing P value, Coefficient value & Remarks.

Para- meters	Correlation Coefficient	P Value	Remark
GSD & CRL	0.90	< 0.001	Very highly significant
BPD & HC	0.98	< 0.001	Very highly significant
BPD & AC	0.98	< 0.001	Very highly significant
BPD & FL	0.98	< 0.001	Very highly significant
FL & AC	0.98	< 0.001	Very highly significant
FL & HC	0.97	< 0.001	Very highly significant
AC & HC	0.98	< 0.001	Very highly significant

according to the menstrual mean weeks from 5-40 weeks. All the observations of the fetal growth parameters are in centimeters. All the measurements were taken & studied. It is found that – Ultrasonic gestational sac size measurements were recorded as early as 5<sup>th</sup> week.<sup>[7]</sup> CRL measurements were recorded starting from 6<sup>th</sup> week of gestation.<sup>[8]</sup> As gestational age advances, all the parameters increases & show linear growth.

From this Table1 it becomes clear that all parameters are very strongly correlated with each other. Correlation between every two parameter is very highly significant.

Table 2: Showing Regression Equations for all parameters.

Parameters	Regression Equation
GSD	Y = 0.76 x – 2.94
CRL	Y = 0.69 x – 3.61
BPD	Y = 0.25 x – 0.25
HC	Y = 0.89 x – 0.77
AC	Y = 0.91 x – 3.26
FL	Y = 0.23 x – 1.40

Expected value of parameter at any week of gestation can be measured by putting the value of week as X & value of parameter as Y & predictive value (Y) for any parameter can be estimated by putting value of X i.e. week.

**Discussion**

A measurement of fetal parts during routine ultrasonography screening has been recommended. During I<sup>st</sup> trimester of pregnancy, GSD & CRL and in II<sup>nd</sup> & III<sup>rd</sup> trimester BPD, HC, AC & FL are measurable.

In this study, gestational sac is identified as early as 5<sup>th</sup> week & CRL is identified by about 6<sup>th</sup> week. This knowledge is important for pregnancy detection, particularly if medical termination is to be done in I<sup>st</sup> trimester. The differentiation between hard & soft tissues

of the embryo is possible after about 10<sup>th</sup> week of gestation when other parameters like BPD, HC, AC, FL can be measured & become more important than CRL.<sup>[4]</sup>

Ultrasonography scanning during pregnancy not only detects skeletal dysplasias but also other structural deformities like renal tract abnormality; anencephaly etc., not only these, it can also detect IUGR, IUD, chromosomal aberrations, hydrocephalus, microcephaly.<sup>[3]</sup>

Thus ultrasonography is the most reliable check on the growth of the fetus.

Table 3: Showing comparison of CRL (in cms) of the present Study with the previous clinical study

Gestational age	Streeter (1921)	Scammon & Calkins (1929)	Aray (1954)	Vare (1976)	Present Study
12	7.4	5.1	5.6	6.4	5.3

From above table it is clear that measurement of CRL in present study are comparable & shows that the actual CRL means values in vivo for human fetuses lie very close to the sonar values derived in this study. The slight variations are considered negligible from statistical point of view.<sup>[9] [10] [11] [12]</sup>

Table 4: Showing comparison of HC of present study by USG with the previous clinical study.

Gestational age in weeks	Scammon and Calkins	Vare (1976)	Kesari G.V. (1979)	Present Study
16	11.79	12.30	11.76	13.26
20	16.68	18.50	17.69	17.13
24	21.01	24.80	20.69	21.20
28	24.96	26.50	25.18	26.47
32	28.59	29.50	28.98	29.42
36	31.99	31.80	30.31	31.67
40	35.19	35.00	32.98	32.76

From the above table it is clear that the measurements of HC in present study are comparable with findings of Scammon and Calkins, Vare and Kesari and shows that the actual HC mean values in vivo for human fetuses lie very close to the sonar values derived in the study.<sup>[10] [11] [12]</sup>

Table 5: Showing comparison of BPD (in cms) of present study with the previous clinical study

Gestational age in weeks	Scammon and Calkins (1929)	Kesari G.V. (1979)	Present Study
16	3.15	2.59	3.40
20	4.53	4.22	4.89
24	5.75	5.18	5.67
28	6.86	6.40	7.02
32	7.88	7.70	8.09
36	8.84	8.10	8.88
40	9.74	8.67	8.96

From the above table it is clear that the measurements of BPD in present study are comparable with findings of Scammon and Calkins, and Kesari and shows that the actual BPD mean values in vivo for human fetuses lie very close to the sonar values derived in the study.<sup>[10] [11] [12]</sup>

### Summary & Conclusion

This cross-sectional study was carried out on 700 pregnant women. Out of 700 pregnant women, 120 were from I<sup>st</sup> trimester & 580 from II<sup>nd</sup> & III<sup>rd</sup> trimester of pregnancy. The data so collected was grouped as per weeks of gestational age i.e. from 5<sup>th</sup> to 40<sup>th</sup> gestational week. In all 36 groups were thus formed & was analyzed.

In the present study, it becomes evident that all parameters increase as gestational age advances. From the above study following conclusions made- 1) Pregnancy can be detected by ultrasonography as early as 5<sup>th</sup> week of gestational age and BPD, HC & AC is possible at 10<sup>th</sup> week of gestation. FL can be measured along 12<sup>th</sup> week of gestation. The differentiation between hard & soft tissues of the embryo is possible after about 10<sup>th</sup> week of gestation.

- 2) All the parameters increase as gestational age advances & show linear growth.
- 3) From this study it becomes obvious that BPD, HC, AC, FL are strongly correlated with each other as well as are found to be statistically very highly significant (P<0.001).
- 4) Following are the regression equation for the parameters (Table 6):

Table 6: Showing regression parameters

Parameters	Regression Equation
GSD	$Y = 0.76 x - 2.94$
CRL	$Y = 0.69 x - 3.61$
BPD	$Y = 0.25 x - 0.25$
HC	$Y = 0.89 x - 0.77$
AC	$Y = 0.91 x - 3.26$
FL	$Y = 0.23 x - 1.40$

- 5) The present study is also comparable to other studies on aborted fetuses taking actual measurements. Thus, accuracy & reliability of ultrasonographic measurement is established.

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Reliability measures the consistency of results over time; between observers; between versions of a test; and between items of a test. Types of reliability and how to measure them. Published on August 8, 2019 by Fiona Middleton. Revised on June 26, 2020. When you do quantitative research, you have to consider the reliability and validity of your research methods and instruments of measurement. Reliability tells you how consistently a method measures something. When you apply the same method to the same sample under the same conditions, you should get the same results. If not, the method of measurement may be unreliable. There are four main types of reliability. Each can be estimated by comparing different sets of results produced. The procedure is used to determine gestational age and to perform fetal measurements for the timely detection of. Copyright 2010 ISUOG. Published by John Wiley & Sons, Ltd. Guidelines. growth abnormalities later in pregnancy. Other goals are to detect congenital malformations and multiple pregnancies. Prenatal screening examination includes an evaluation of the following: - cardiac activity; - fetal number (and chorionicity if multiple pregnancy); - fetal age/size; - basic fetal anatomy; - placental appearance and location. What ultrasonographic equipment should be used? For routine screening, equipment should have at least the following. The reliability coefficient may be looked upon as the coefficient of correlation between the scores on two equivalent forms of test. The two equivalent forms are to be possibly similar in content, degree, mental processes tested, and difficulty level and in other aspects. One form of the test is administered on the students and on finishing immediately another form of test is supplied to the same group. 1. A test can be divided into two equal halves in a number of ways and the coefficient of correlation in each case may be different. 2. This method cannot be used for estimating reliability of speed tests. 3. As the test is administered once, the chance errors may affect the scores on the two halves in the same way and thus tending to make the reliability coefficient too high. Measurement of system parameters/informations One of the important functions of the instruments is to determine the various parameters/informations of the system or a process. In fact, condition based system of operation is being used very widely these days in a number of situations like medical care of patients or maintenance of machines. Consequently, the final assemble of the machine/system is free from defects. This improves the reliability of product completely. Medical field Instruments such as magnetometers, radiation detectors and X Ray fluoroscopes enable sensing and detection of physical quantities, which cannot be sensed or detected by human beings. Measures of inter-rater-reliability can also serve to determine the least amount of divergence between two scores necessary to establish a reliable difference. (2) Inter-rater agreement, including proportion of absolute agreement, where applicable also magnitude and direction of differences. The proportion of (reliable) agreement was assessed using both reliability estimates in order to demonstrate how the choice of reliability measure impacts the evaluation and interpretation of rater agreement. In addition to the proportion of absolute agreement, information about the magnitude of (reliable) differences and about possible systematic direction of differences is also relevant for the comprehensive assessment of rater-agreement.