Original Research Article

A Comparative Study of Ultrasonographic Second & Third Trimester Gestational Parameters with Clinical Study on Aborted Fetuses Taking Actual Measurements

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ABSTRACT

The fetal age period is expressed in terms of menstrual age and not in embryonic age. Ultrasound is the name given to high frequency sound waves, over 20,000 cycles per second. The project was undertaken keeping in mind the following aims, to present a data collected by Ultrasonographic Parameters, to demonstrate the correlation of all parameters with each other, to derive regression equation and to compare the results of other studies where actual measurements of the aborted fetuses of various gestational age were taken. The project is carried out in Radiology Department .Normal pregnant females in IInd and IIIrd trimesters were studied by ultrasonography for estimation of gestational age of the fetus.   In this study, the gestational age of the fetus is estimated after using multiple parameters like BPD, HC, AC, FL. This cross-sectional study was carried out in 580 pregnant women. From the above study following conclusions were made. The ultrasonographic measurement of the fetal BPD, HC and AC is possible at 10th week of gestation, FL can be measured along 12th week of gestation. It becomes obvious that all parameters are strongly correlated with each other as well as are found to be statistically very highly significant ($P < 0.001$). Regression equation for each parameter is derived. The present study is also comparable to other studies carried out on aborted fetuses taking actual measurements. Thus, accuracy and reliability of ultrasonographic measurement is also established.

Keywords: Gestational Parameters, Aborted Fetuses Measurements, Regression Equation, Correlation.

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. Numerous tissues and organs are formed and function in perfect harmony. During early two months we call the developing individual an embryo. Form the third month until birth we call it a fetus. [1] The fetal age period is expressed in terms of menstrual age and not in embryonic age. Fetal age actually begins at conception and an equivalent term is conceptional age. Gestational age is used synonymously with menstrual age.

Ultrasound is the name given to high frequency sound waves, over 20,000 cycles per second (20 kHz). These waves, inaudible to humans, can be transmitted in beams and are used to scan the tissue of the body. So now a tool has become available for studying the developing fetus while it is still within the confines of intrauterine environment without producing biological changes and resulted in detection of upto 70% of all major congenital malformations. Ultrasonic diagnosis employs sound waves frequencies far higher than can be recognized by human ear. These ultrasonographic waves are produced from a transducer and travel through human tissues at a velocity of 1500 meter per second. Transducer contains crystal structures that convert electrical energy to ultrasound waves and returning echoes to electrical energy. Therefore each crystal in a transducer acts both as a transmitter as well as a receiver. With real time ultrasonography, the transducer used is a linear array transducer, which has a frequency of 3-5 MHZ. [2]

Routinely gestational age is divided into 3 trimesters.

● First trimester extends from 1st week to 12 weeks.
● Second trimester extends from 13 weeks to 28 weeks.
● Third trimester extends from 29 weeks upto birth.

In the first trimester, the gestational sac and the embryo are the two major structures to be identified. By abdominal scanning, the gestational sac can be routinely imaged by 5th gestational weeks and the crown-rump length, a measurement of the embryo, by 6th to 7th week. [3] According to Hadlock F.P. [4] various parameters used in 2nd and 3rd trimesters are biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). It is observe that the health standards of Indian adults vary widely from region to region. Similar regional variations are expected in the health standards of Indian babies. Such differences are due to ethnic and socioeconomic differences in a multiracial developing country as India. Thus, it is natural that growth rates of Indian fetuses too would exhibit wide regional variations. Starting from Streeter (1920) [5] to Hearn (1984), various workers have studied the fetal growth rate by measuring fetal parts and correlated the same with the gestational age. The importance of accurately knowing the gestational age of a pregnancy is quite clear to anyone taking care of a pregnant woman.

Aims and Objectives:
1) To present a data collected by Ultrasonographic Parameters like BPD, HC, AC& FL.
2) To demonstrate the correlation of all parameters with each other.
3) To derive regression equation for each parameter.
4) To compare the results of other studies where actual measurements

of the aborted fetuses of various gestational age were taken.

MATERIAL AND METHODS

The project was carried out in Radiology Department with collaboration with Gynecology Department .Normal pregnant females in IInd and IIIrd trimesters were studied by ultrasonography for estimation of gestational age of the fetus. In this study, the gestational age of the fetus is estimated after using multiple parameters like BPD, HC, AC, FL. [6, 7] The Study was carried in 580 Pregnant women, who were chosen on the following basis:-

Subjects chosen were from 18-34 years of age. A woman having her first pregnancy at the age of 30 years or above was excluded from this study. All patients had an uncomplicated obstetric history and an accurate knowledge of the last menstrual period so the cases excluded were:-

a) Hypertensive disorders in pregnancy.
b) Haemorrhage in pregnancy.
c) Hypermesis in pregnancy.
d) Medical and surgical illness complicating pregnancy.

Therefore, in this study only normal pregnant females were selected. Ultrasound screening examination was performed on the subjects with a full urinary bladder. The subjects were placed on ultrasonic scanning table in supine position with their abdomen exposed. Then a mineral oil jelly 'Sonogel' was applied all over the surface to ensure an airless contact between the tissue and transducer probe. While carrying out this study ultrasonic equipment used is "Real Time Ultrasonography" with linear array sector transducer.

Plane used	Diameter calculated
Head	Biparietal diameter (BPD) Head circumference (HC)
Abdomen	Abdominal circumference (AC)
Skeleton	Femur length (FL)

So in this study 4 parameters were calculated as examination of various fetal anatomical structures for confirmation of gestational age.
The parameters used are:-
1. BPD -In second and third trimester.
2. HC - In second and third trimester.
3. AC- In second and third trimester.
4. FL - In second and third trimester.

The data collected was thus subjected to the following statistical tests-
Mean (average), Standard deviation, Coefficient of variation, P value, Correlation Coefficient, Multiple linear regression analysis.

OBSERVATIONS

The observations were made by using the methods described earlier. These observations were arranged in tables and discussed systematically. The data so collected was tabulated according to the menstrual mean weeks from 13-40 weeks.

The statistical mean & standard deviation of each parameter for each week was calculated separately. The weeks of gestation were defined a completed weeks. For example 13th week refers to 13.1 to 13.6 weeks of menstrual age. All the observations of the fetal growth parameters are in centimeters.

Table No. 1: Showing correlation coefficient between the parameters studied (BPD, HC, AC&FL)

Parameters Studied	Correlation Coefficient (r)
Gestational age and BPD	0.96
Gestational age and HC	0.97
Gestational age AC	0.97
Gestational age and FL	0.97
BPD and HC	0.98
BPD and AC	0.98
BPD and FL	0.98
FL and AC	0.98
FL and HC	0.97
AC and HC	0.98

According to this table correlation coefficient between BPD and HC, BPD and AC, BPD and FL, FL and AC, FL and HC, AC and HC are   0.98, 0.98, 0.98, 0.98, 0.97, 0.98 respectively. Based on the above results it is observed that all the parameters are very strongly correlated with each other so that as gestational age advances all parameters increases accordingly, in normal pregnant females.

Table No. 2: Showing P value, remarks, coefficient value.

Parameters	Correlation Coefficient	P value	Remarks
BPD and HC	0.98	< 0.001	Very highly significant
BPD and AC	0.98	< 0.001	Very highly significant
BPD and FL	0.98	< 0.001	Very highly significant
FL and AC	0.98	< 0.001	Very highly significant
FL and HC	0.97	< 0.001	Very highly significant
AC and HC	0.98	< 0.001	Very highly significant

From this table it becomes clear that, all parameters are very strongly correlated with each other. According to this table the correlation between every 2 parameters is very highly significant.

Table No. 3: Showing regression equations for all parameters.

Parameters	Regression Equation
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

By regression equation of y = 0.25x – 0.25, expected value of BPD at any week of gestation can be measured by putting the value of week as x and value of parameter as y. Similarly expected

value of HC, AC, FL can be measured. From above table it becomes evident that predictive value (y) for any parameter (BDP, HC, AC, FL) can be estimated by putting value of x i.e. week.

Table No. 4: Showing comparison of HC of present study by USG with the previous clinical study carried out on aborted fetuses.

Gestational age in weeks	Scammon and Calkins (1929)	Vare (1976)	Kesari G.V. (1979)	Present study (2005)
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 the findings of Scammon and Calkins, Vare and Kesari [8, 9, 10] and shows that the actual HC mean values in vivo for human fetuses lie very close to the sonar values derived in this study.

Table No. 5: Showing comparison of BPD (in cms) of present study with the previous clinical study carried out on aborted fetuses.

Gestational age in weeks	Scammon and Calkins (1929)	Kesari G.V. (1979)	Present study (2005)
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	8.96
40	9.74	8.67	8.88

From the above table it is clear that the measurements of BPD in present study are comparable with the findings of Scammon and Calkins, Vare and Kesari [8, 9, 10] and shows that the actual BPD mean values in vivo for human fetuses lie very close to the sonar values derived in this study.

SUMMARY AND CONCLUSION

Estimation of gestational age by USG is of high importance for diagnosis, investigation and treatment of fetus in vitro. That's why estimation of gestational age by different parameters has acquired importance in clinical practice.

This cross-sectional study was carried out in 580 pregnant women in the Department of Radiology. The patients were subjected to real time transabdominal ultrasonography. All the patients had sound

knowledge of their menstrual dates. BPD, HC, AC & FL were used in 2nd and 3rd trimester of pregnancy. The data so collected was grouped as per weeks of gestational age i.e., from 13th to 40th gestational week. In all 28 groups were thus formed, was analyzed by calculating range, mean, standard deviation, correlation coefficient between every two parameters and regression equation for each parameter. 'p' value was calculated to see whether the study is statistically significant or not. In this study, with each fetus being measured only one the data is analyzed with gestational age as a dependent variable and equations are generated. Those will give predictive values for only given menstrual age. In the present study, it becomes evident that all parameters increase as gestational age advances.

From the above study following conclusions were made-

1. The ultrasonographic measurement of the fetal BPD, HC and AC is possible at 10th week of gestation, FL can be measured along 12th week of gestation. Differentiation between hard and soft tissues of the fetus can be made as early as 10th week of gestation by ultrasonography. All the parameters increase as gestational age advances.
2. 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).
3. Regession equation for each parameter is derived.
4. The present study is also comparable to other studies carried out by Streater, Scammon and Calkins, Arey, Hamilton on aborted fetuses taking actual measurements. Thus, accuracy and reliability of ultrasonographic measurement is also established.

Usefulness of Ultrasonography as an index for the measurement of gestational age is beyond doubt. All the parameters show linear growth as gestational age advances and they are strongly correlated with each other. While estimating gestational age of the fetus by multiple fetal growth parameters, the fetal anatomical structures also get examined and if any abnormality is present, it becomes obvious while the fetus is in uterus. So ultrasonography has diagnostic as well as therapeutic and prognostic values in clinical practice.

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