ULTRASONOGRAPHIC STUDY OF TRANSVERSE DIAMETER OF FETAL CEREBELLUM AND LENGTH OF FEMUR AS MARKERS FOR ACCURATE ESTIMATION OF GESTATIONAL AGE

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ABSTRACT

Introduction: Prediction of gestational age (GA) based on sonographic fetal parameters is essential in modern obstetrics and continues to remain an important component in the management of pregnancies. A variety of sonographic fetal parameters have been shown to correlate well with gestational age. Transcerebellar diameter (TCD) is one such fetal parameter that has remained consistently superior in predicting gestational age.

Aims and objective: Compare the efficacy of transverse diameter of fetal cerebellum and length of fetal femur in predicting gestational age.

Materials and Methods: About 100 pregnant women seeking antenatal care and undergoing routine ultrasound examination were selected for the study. Fetal transverse cerebellar diameter and femoral length measurements were recorded along with gestational age. Ultrasonographic fetal maturity was determined using all biometric parameters and efficacy of transcerebellar diameter and femoral length was compared.

Results: Patients were divided into five groups as per their gestational age. In each group mean and standard deviation for values of TCD and FL was calculated and their statistical significance is found out.

Discussion: Our study found that both TCD and FL go on increasing as gestational age increases. Results of this study are compared with other workers.

Conclusion: Our study shows that TCD is equivalent to FL as a biometric parameter for evaluating gestational age in first & second trimester but it less effective than FL in the third trimester.

KEY WORDS: Transcerebellar diameter, gestational age, Femoral length, Ultrasonography.

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INTRODUCTION

Accurate estimation of gestational age is pivotal in efficient obstetric planning and also helps us to estimate fetal malformation or

growth retardation. Failure can result in iatrogenic prematurity or postmaturity, both being associated with increased perinatal morbidity and mortality [1] and can result in grave

complications for the patient and liability for health care providers [2].

The estimation of pregnancy dates is also important for the mother, who wants to know when to expect the birth of her baby, and for her health care provider, so they may choose the way in which to perform various screening tests and assessments [3].

Objective knowledge of the expected date of delivery is therefore essential in the management of all pregnancies particularly with regard to the method of delivery, management of high risk pregnancies, and elective planned induction of labour and elective caesarean for previous caesarean section deliveries [2].

The three basic methods used to help estimate gestational age (GA) are menstrual history, clinical examination, and ultrasonography.

The spectacular improvement in ultrasound imaging quality in the past decade has contributed to the rapid increase in its use as a diagnostic tool [2]. Prediction of gestational age (GA) based on sonographic fetal parameters is therefore the cornerstone in modern obstetrics and continues to remain an important component in the management of pregnancies with fetuses who have growth disturbances. Identification of aberrant growth as well as growth disturbances across the spectrum of GA in both healthy fetuses and those with genetic abnormalities will be helpful for optimal fetal surveillance [4].

The present study was undertaken to evaluate the efficiency of ultrasonographic fetal parameter transcerebellar diameter as against conventional parameter femur length in normal pregnant mother between 14 to 40 weeks for accurate estimation of gestational age [5].

MATERIALS AND METHODS

The present study was conducted in the Dept of Anatomy in association with Dept of Radiodiagnosis of MIMER Medical College, Talegaon Dabhade after obtaining proper approval from institutional ethics committee.

Inclusion Criterion: About 100 pregnant women between 14 to 40 weeks attending the antenatal clinic for routine ultrasound examination and seeking antenatal care were selected for the

study. Normal singleton pregnancies of 14 and 40 weeks gestation with known last menstrual period were included in study.

Exclusion Criteria: Multifetal pregnancies and singleton pregnancies with any kind of pregnancy related complication e.g. IUGR, PIH were excluded from the study. Also patients who were not sure about their last menstrual period were excluded.

Sonographic transverse views of intracranial anatomy were obtained using high resolution scanning system ; the Wipro Logic Tm GE – 200 ultrasonography machine with linear 5 MHz and sector array 3.5 MHz frequency transducers [2]. Transcerebellar diameter measurements were obtained by placing the sonography machine's on-screen calipers at the outer margins of the cerebellum, at 90 degree to the long axis of the cerebellum across its widest point in the suboccipitobregmatic plane of the head [3-5]. The femur length (FL) was measured from the greater trochanter to the lateral condyle of femur. The gestational age is calculated by using all biometric parameters BPD, HC, AC and FL. It is correlated with the gestational age as shown by TCD and FL.

OBSERVATIONS AND RESULTS

The cases are divided into five groups according to their gestational age as calculated by using all parameters.

Group A	Group B	Group C	Group D	Group E
14-20 weeks	21-25 weeks	26-30 weeks	31-35 weeks	36-40 weeks

Later TCD & Femoral length measurements are compared with the gestational age calculated by four conventional parameters. The findings of TCD & FL measurements with the corresponding gestational age findings are then tabulated.

Graph 1: Showing distribution of Transverse cerebellar diameter with GA.

Table 1: Showing TCD and FL measurements in Group A – 14 – 20 weeks.

Sr. No.	Gestational age	(T.C.D.) mm	F. L. (mm)
1	14wks 0 days	13.8	13
2	15 wks 5 days	14.2	19.6
3	16 wks 0 days	15	17.5
4	17 wks 1 days	15.7	23.8
5	17 wks 4 days	17.9	23.4
6	17 wks 6 days	18	25.4
7	17 wks 6 days	20	26
8	18 wks 0 days	16	27
9	18 wks 0 days	17.9	25.4
10	18 wks 5 days	19.2	27.9
11	18wks 6 days	21.3	30.4
12	19 wks 0 days	19.6	29.6
13	19 wks 0 days	20.4	33.4
14	19 wks 1 days	18.3	31.7
15	19 wks 1 days	18.8	31.3
16	19 wks 2 days	22.1	30
17	19 wks 5 days	19.2	32.5
18	19 wks 5 days	19.6	32.9
19	19 wks 6 days	19.2	33.8

Table 3: Showing TCD and FL measurements in Group C – 26 – 30 weeks.

Sr. No.	Gestational age	(T. C. D.) mm	F. L. (mm)
1	25 wks 4 days	28.4	50
2	25 wks 5 days	30	47.5
3	25 wks 6 days	25.4	49.6
4	26 wks 0 days	26.7	46.7
5	26 wks 2 days	30	45.5
6	26 wks 2 days	28	47
7	26 wks 3 days	27.1	48.8
8	26wks 2 days	26.7	49.6
9	27 wks 0 days	29	52
10	27 wks 0 days	30.6	47.5
11	27 wks 4 days	35	57
12	27 wks 5 days	34	54.2
13	27 wks 6 days	34	53.8
14	27 wks 6 days	36	50.9
15	28 wks 1 days	35	53
16	28 wks 2 days	25.4	43
17	28 wks 3 days	32.9	53.4
18	28 wks 5 days	28	54.2
19	28 wks 5 days	28.4	54.2
20	28 wks 6 days	30	55.5
21	28 wks 6 days	31.7	56.7
22	29 wks 0 days	40	55.9
23	29 wks 4 days	39	58.8
24	30 wks 0 days	30	59

Table 2: Showing TCD and FL measurements in Group B - 21-25 weeks.

Sr. No.	Gestational age	(T. C. D.) mm	F. L. (mm)
1	20 wks 3 days	20.4	34.8
2	21 wks 1 dy	18	37.5
3	21 wks 1 days	22	37.1
4	21 wks 4 days	22.5	38.8
5	21 wks 6 days	22.2	37.9
6	21/22 wks 0 days	22.5	38.4
7	21wks 0 days	22	36
8	22 wks 0 days	21.7	37.9
9	22 wks 2 days	24	40.4
10	22 wks 5 days	22.5	40
11	23 wks 3 days	26	43
12	24 wks 0 days	25	43.4
13	24 wks 0 days	26.3	41
14	24 wks 0 days	26.7	47.1
15	24 wks 3 days	30	66
16	24 wks 4 days	30	46.3
17	24 wks 4days	26.7	46.7
18	24 wks 6 days	24	45.9
19	25 wks 0 days	28.8	41.7

Table 4: Showing TCD and FL measurements in Group D – 31 – 35 weeks.

Sr. No.	Gestational age	(T. C. D.) mm	F. L. (mm)
1	30 wks 2 days	38	57
2	30 wks 3 days	39	61
3	30 wks 5 days	32.1	53
4	30wks 6 days	29.2	59.6
5	31 wks 5 days	37	62.1
6	32 wks 0 days	33	65
7	32 wks 0 days	35.4	61.7
8	32 wks 1 days	32.1	58.8
9	32 wks 3 days	42	66
10	32 wks 4days	41	63
11	32 wks 6 days	32.9	63.8
12	33 wks 0 days	26	65.5
13	33 wks 0 days	42	64.2
14	33 wks 0 days	41	66.7
15	33 wks 5 days	40	66.3
16	34 wks 0 days	35.9	66.3
17	34 wks 3 days	35	70
18	34 wks 3 days	34.6	70
19	34 wks 4 days	40	71
20	34 wks 5 days	39	70
21	35 wks 0 days	38.8	68
22	35 wks 0 days	40	72.6
23	35 wks 0 days	39.5	70.5

Table 5: Showing TCD and FL measurements in Group E – 36 to 40 weeks.

Sr. No.	Gestational age	(T. C. D.) mm	F. L. (mm)
1	35 wks 1 days	39.6	71
2	35 wks 2 days	41.2	69
3	35 wks 4 days	39.6	69.2
4	35 wks 4 days	38.4	73
5	35 wks 5 days	35.9	68
6	35 wks 5 days	40	71
7	35 wks 6 days	38.4	72.1
8	36 wks 0 days	38.8	72.6
9	36 wks 0 days	39	71.3
10	36 wks 1 days	39	66.7
11	36 wks 1 days	42.5	72.1
12	36 wks 1 days	54	70.1
13	37 wks 0 days	37	74
14	37 wks 0 days	37.9	72.6
15	38 wks 3 days	42.5	75.1
16	38 wks 5 days	41.3	70.9
17	38 wks 6 days	42	75.5

Mean and standard deviations of TCD & FL are then calculated for each group and the statistical significance of TCD & FL is calculated for each group separately.

Table 6: Showing mean and standard deviation of TCD & FL in each group of gestational age.

Group		TCD	FL
A	Mean	18.2211	27.0842
	Standard deviation	2.32249	5.73084
B	Mean	24.2789	42.1
	Standard deviation	3.25467	6.90064
C	Mean	30.8875	51.825
	Standard deviation	4.05605	4.34183
D	Mean	36.6739	64.8739
	Standard deviation	4.27064	4.91817
E	Mean	40.4176	71.4235
	Standard deviation	3.96677	2.37422
Total	Mean	30.1902	51.6137
	Standard deviation	8.5953	16.15907

Table 7: Showing correlation of gestational age with TCD & FL.

GA	TCD	FL
A	0.838	0.977
	(0.0001)**	(0.0001)**
B	0.86	0.684
	(0.0001)**	(0.001)*
C	0.509	0.738
	(0.011)	(0.0001)**
D	0.298	0.937
	(0.168)	(0.0001)**
E	0.149	0.537
	(0.569)	(0.017)*

** . Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Graph 2: Showing distribution of Femur length with GA. Mean Femur length with respect to GA groups

DISCUSSION

Historically, the dating of pregnancies was based on the first day of the last menstrual period (LMP) in a regular 28- day menstrual cycle [1]. Naegle's rule is the most common method of pregnancy dating. The Expected date of delivery (EDD) is calculated by counting back three months from the menstrual period and adding seven days. Inaccuracy occurs because many women do not have regular 28-day cycles or conceive on day 14, and many others are not certain of the date of their last period which makes it difficult to assess accurate gestational age based on date of their last menstrual cycle. In addition, early pregnancy bleeding or recent use of hormonal contraceptives may lead to an incorrect assumption of the date of ovulation [3].

Clinical examination for gestational age is usually done by obstetricians; which apart from being liable for subjective variation; can not rule out growth retardation. Predictions are passed based on menstrual history, maternal sensation of fetal movement, assessment of uterine size by bi-manual examination and uterine fundal height measurement. However it has been reported that, even in best known cases, the menstrual history and fundal height measurement techniques are also fraught with error [2]. Since the introduction of diagnostic ultrasound, more reliable approaches to the dating of pregnancies have developed. These include various sonologically derived fetal parameters to date gestational age accurately. In the first trimester these are gestational sac diameter and volume and crown rump length measurement. In the second trimester, most commonly used

biometric indices for dating pregnancies are the fetal biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) [1]. Among these, femur length parameter is considered superior to other parameters in predicting GA accurately as it can resist to external deformation better. Conditions which alter shape of skull may change BPD as well as HC eg. dolichocephalic or brachycephalic skulls [6]. In breech presentation BPD is less than actual [7]. AC measurement is subject to change with fullness of bladder & bowels. Therefore BPD, HC and AC have their own limitations. Therefore newer parameters are constantly being explored for their efficiency e.g. TCD, Humerus length, fetal kidney length [1], nasal bone length [2], three dimensional fractional limb volume [8], umbilical venous Doppler in growth restricted fetuses, etc.

Fetal Transcerebellar diameter (TCD) is one such fetal parameter that has evolved as a superior one in predicting GA in both singleton and twin gestations [3].

The fetal cerebellum is surrounded by dense petrous temporal bones and occipital bone of the posterior cranial fossa which can resist deformation by external pressure better than parietal bones of skull. Moreover there is relative preservation of normal cerebellar growth in growth-restricted fetuses and a similar rate of growth in singleton and multifetal gestations. The transverse cerebellar diameter therefore represents an independent biometric parameter that can be used in both singleton and multifetal pregnancies to assess normal and deviant fetal growth [3,4].

Fig. 1: Showing transcerebellar diameter.

Fig. 2: Showing Biparietal Diameter.

Fig. 3: Showing Head Circumference.

Fig. 4: Showing abdominal circumference.

Fig. 5: Showing fetal femur length.

Various studies have evaluated usefulness of TCD. Martin R. Chavez, , Cande V. Ananth, et al [4] have shown that TCD is effective in calculating GA at the extremes of fetal growth - small for age & large for age fetuses. Jose Araujo Holanda et al [9] have shown that there is no variation in TCD measurements in male & female fetuses of same age indicating that TCD does not differ between genders. A study conducted by Sabine J. Roza [10] on effects of maternal smoking in pregnancy has shown that TCD is most adversely affected than other biometric parameters.

Marwa Mohammed El-Saghir Abd El-Aziz [3] have studied the efficacy of TCD against BPD in estimating gestational age in singleton and twin pregnancies.

Chavez MR, Ananth CV et al [4] concluded that TCD is reliable and accurate in predicting gestational age even at extremes of foetal growth.

Malik R, Pandya VK et al [11] have concluded that TCD showed 92% predictive accuracy for gestational age. In this study the TCD/AC ratio remained fairly constant throughout pregnancy which proved that it is a useful independent gestational age parameter.

Malik G, Waqar F et al [12] reported that transverse cerebellar diameter varied in a linear fashion in third trimester, while transverse cerebellar diameter/abdominal circumference (TCD/AC) ratio remained constant in second half of pregnancy [5].

A.S.M. Vinkesteyn, P.G.H. Mulder et al [13] reported that in the normally developing fetus the TCD increases with advancing gestational age. Increased TCD/AC values are suspicious of fetal growth restriction. The perinatal mortality in growth-restricted fetuses with a small cerebellum is increased twofold over that of other foetuses.

Meyer WG, Gauthier DW et al [14] reported that TCD/AC ratio is a stable gestational age independent parameter that may be useful in the early detection of foetal growth abnormalities.

Still various studies are going on which are comparing efficacy of TCD against BPD & FL, efficacy of TCD in IUGR fetuses and so on [5]. Prabhat Goel, Mukesh Singla et al [15] found that TCD is a good marker for estimation of gestational

age. They did a study of ultrasonographic measurements of Transverse cerebellar diameter to assess the Gestational age on 50 antenatal patients (20–40 years of age) between 14–40 weeks of pregnancy. Mean TCD was 17.32 mm in 14–20 weeks of gestation, 26.63 mm in 21–30 weeks and 40.73mm in 31–40 weeks. Regression analysis indicated a significant relationship between TCD and gestational age.

CONCLUSION

In the present study, the five groups were subjected to statistical significance and it was found that TCD measurements are significant and equivalent to FL in first two groups i.e. gestational age between 14 to 25 weeks. So this study shows that TCD is equivalent to FL as a biometric parameter for evaluating gestational age in first & second trimester but it less effective than FL in the third trimester.

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Conflicts of Interests: None

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