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ACCURACY OF TRANSCEREBELLAR DIAMETER IN ESTIMATION OF GESTATIONAL AGE IN SECOND AND THIRD TRIMESTERS OF PREGNANCY IN COMPARISON TO STANDARD FETAL BIOMETRY

By

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ABSTRACT

Background: Accurate pregnancy determination is one of the most useful assessments of pregnancy, which depends on whether or not the patient is pregnant.

Objective: To estimate gestational age using trans cerebellar diameter in comparison to femur length and biparietal diameter in 2nd and 3rd trimesters of pregnancy according to first day of last menstrual period.

Patients and methods: This prospective study included 90 pregnant women. All cases were selected from Obstetrics and Gynecology Department, Sayed Galal Hospital seeking antenatal care, routine ultrasound during the period from November 2020 till June 2021. The study had been conducted at Obstetrics and Gynecology Department, Faculty of Medicine, Al-Azhar University. Regarding the study group, they had been divided into three groups: Group 1: 14-20 weeks (early second trimester), Group 2: 21-29weeks (late second trimester), and Group 3: 30-40 weeks (third trimester).

Result: Gestational age by trans-cerebellar diameter (TCD) in women with gestational age was accurate in 92% of patients, while in women with gestational age ranged between 21 – 29 weeks group was accurate in 93.9% of patients, and in women with gestational age ranged between 30 – 40 weeks group was accurate in 90.6% of patients with no statistically significant differences between groups.

Conclusion: Trans-cerebellar diameter was more reliable method of gestational age determination in third trimester of pregnancy than biparietal diameter. Trans-cerebellar diameter (TCD) and femur length (FL) can be used as a tool to assist in the assessment of gestational age in third trimester.

Keywords: Gestational Age, Intrauterine, Trans-Cerebellar Diameter, Biparietal, Pregnancy.

INTRODUCTION

The cerebellum develops from the dorsolateral part of the alar laminae of the metencephalon. In the embryo, the cerebellum appears at the end of the fifth week as a swelling overriding the fourth ventricle *(Taipale and Hiilesmaa, 2010)*.

Assessment of the gestational age (GA) is important in the management of pregnancy and the most frequently used biometric parameters for the estimation of

gestational age are the fetal biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) *(Salomon et al., 2011)*.

Unfortunately, some of these fetal parameters are nonspecific as they depend upon normal fetal growth as well as on the regulation of menstrual cycle, and the certain date of onset of LMP; BPD, HC, AC, and FL are, for instance, adversely affected in fetuses with uteroplacental insufficiency, which results in the redistribution of cardiac output with brain-sparing effect and growth restriction, After 26 weeks of gestation, the BPD becomes unreliable in fetuses with brachycephaly and dolichocephaly; the FL is shortened in fetuses with achondroplasia, while the abnormality of liquor volume affects the accuracy of the sonographic measurement of the FL *(Eze et al., 2020)*.

Since cerebellum lies in the posterior cranial fossa, surrounded by the dense petrous ridges and the occipital bone, so it can withstand deformation by extrinsic pressure better than the parietal bones so transverse cerebellar diameter (TCD) developed as an alternative parameter for fetal brain growth and for estimation of gestational age. The fetal cerebellum can be visualized by ultrasound easily Therefore, imaging the posterior cranial fossa is becoming an integral part of many routine fetal sonograms *(Goldstein et al., 2010)*.

Several authors working on transverse cerebellar diameter have correlated it well with the gestational age, even in the presence of growth retardation and found it as a better marker for gestational age estimation as compared to other clinical and biometric parameters *(Ergaz et al., 2015)*.

This work aimed to estimate gestational age using transcerebellar diameter in comparison to femur length and biparietal diameter in 2nd and 3rd trimesters of pregnancy according to first day of last menstrual period.

PATIENTS AND METHODS

This prospective study included 90 pregnant women. All cases were selected from Obstetrics and Gynecology Department, Sayed Galal Hospital seeking antenatal care, routine ultrasound during the period from November 2020 till June 2021. The study had been conducted at Obstetrics and Gynecology Department, Faculty of Medicine, Al-Azhar University.

Regarding the study group, they had been divided into three groups: Group 1: 14-20 weeks (early second trimester), **Group 2:** 21-29 weeks (late second trimester), and **Group 3:** 30-40 weeks (third trimester).

Regarding the patients included in our study, they had been subjected to trans-abdominal ultrasound for determination of the gestational age by the usual fetal biometric measurements (biparietal diameter and femur length), and also the measurement of transverse cerebellar diameter had been obtained.

Inclusion criteria: Maternal age from 20-40 years (in childbearing period), Gestational age was confirmed by the first day of the last menstrual period in patients who were sure of their dates/or early ultrasound scan, singletone and uncomplicated pregnancy.

Exclusion criteria: Patients who were neither unsure of dates nor underwent early ultrasound scan, patients with associated fetal anomalies, patients with multiple gestations, Patients with chronic medical disorders (diabetes mellitus or hypertension) and Patients with pregnancy induced disorders (preeclampsia or gestational diabetes).

Operational design: The procedure was explained to all women participating in the study. A written consent was taken from all patients before starting the study with counseling about risk and benefit of study.

All Patients were subjected to:

Complete history taking: Personal history including: name, Age, marital state, address menstrual history: including age of Menarche, menstrual disturbance, dysmenorrhea, related symptoms, Obstetric history including parity and mode of delivery, Present history: of chronic diseases and medication, Past history of HTN, DM, Family history of similar condition or diabetes, History of allergy to any medication and surgical history of operation, laparoscopic interference, treatment of hirsutism by Laser.

Examination:

A. **General examination:** Evaluation of vital signs and measurement weight, height (BMI)

B. **Abdominal and local clinical examination:** To assess fundal level and gestational age, Scar of previous operation, Mass, tenderness or rigidity and any abdominal or pelvic clinically detectable pathology.

C. **Routine trans vaginal examination.**

D. **Ultrasound examination:** Ultrasound examination (Trans-abdominal) via GE voluson E6, using RAB6-D abdominal probe é 3.5 MHz bandwidth, in Ultrasound unit of Obstetrics and Gynecology Department, Sayed Galal Hospital, mainly to measure the fetal biparietal diameter, femur length and the transverse cerebellar diameter as parameters of gestational age estimation. The technique of trans-abdominal ultrasound was included performing the scan on all patients while women are in a tilted position with the head of the bed raised 30 degrees and with a small pillow under the right loin. All measurements had been taken three times; the average of which had been noted.

Measurement of the transcerebellar diameter: Transthalamic view of BPD was obtained, then the probe slightly rotated downwards, toward the fetal neck, and the posterior horns of the lateral ventricles disappeared from the view to be replaced by the cerebellum. The trans-cerebellar diameter was measured at 90 degree to the long axis of the cerebellum across its widest point, using the outer to outer method.

Figure (1): Measurement of TCD (Measurements were obtained by placing the calipers of the ultrasound machine at the outerto-outer margins of the cerebellum).

Ethical Consideration: Study protocol had been submitted for approval by Institution Research Board (IRB) of faculty of medicine Al Azhar University. Informed verbal consent had been obtained from each participant sharing in the study. Confidentiality and personal privacy had been respected in all levels of the study.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent, and were compared by Chi2 test. Quantitative data were described using range (minimum and maximum), mean and standard deviation. Chi-square test: For categorical variables, to compare between different groups. P value < 0.05 was considered significant.

RESULTS

The demographic data of the studied group. Age was ranged from 20-40 years with a mean value 29.90±6.113 years. BMI was ranged from 21.1-33.9 kg/m2 with a mean value 26.52±2.557 kg/m2. More than half of the studied sample was from urban places (61.1%). More than half of the studied sample had multi gravida (57.8%) **(Table 1)**.

Table (1): Distribution of studied sample according to patient's demographic data

Patients / Parameters	Number	Percent
Age (years)		
Range	20-40	
Mean±S.D.	29.90±6.113	
BMI		
Range	21.1-33.9	
Mean±S.D.	26.52±2.557	
Residence		
Urban	55	61.1
Rural	35	38.9
Parity		
Primigravida	38	42.2
Multi gravida	52	57.8
Gestational age by LMP		
14 – 20 weeks	25	27.8
21 – 29 weeks	33	36.7
30 – 40 weeks	32	35.6
Range	14-40	
Mean±S.D.	26.36±8.073	

Gestational age by LMP of the studied group ranged from 14-40 weeks with a mean value 26.36±8.073 weeks. Gestational age by BPD in women with gestational age was accurate in 84% of patients, while in women with gestational age ranged between 21 – 29 weeks group was accurate in 75.8% of patients, and in women with gestational age ranged between 30 – 40 weeks group was accurate in 62.5% of patients with no statistically significant differences between groups. Gestational age by FL in women with gestational age was accurate in 68% of patients while in women with gestational age ranged between 21 – 29 weeks group was accurate in 87.9% of patients and in women with gestational age ranged between 30 – 40 weeks group was accurate in 84.4% of patients with no statistically significant differences between groups. Gestational age by TCD in women with gestational age was accurate in 92% of patients while in women with gestational age ranged between 21 – 29 weeks group was accurate in 93.9% of patients and in women with gestational age ranged between 30 – 40 weeks group was accurate in 90.6% of patients with no statistically significant differences between groups **(Table 2)**.

Table (2): Accuracy of gestational age by BPD, FL and TCD

Groups / Parameters	14 – 20 weeks (n=25)		21 – 29 weeks (n=33)		30 – 40 weeks (n=32)		P value
	No.	%	No.	%	No.	%	
Gestational Age by BPD:							
Accurate	21	84.0	25	75.8	20	62.5	0.176
Inaccurate	4	16.0	8	24.2	12	37.5	
Gestational Age by FL							
Accurate	17	68.0	29	87.9	27	84.4	0.134
Inaccurate	8	32.0	4	12.1	5	15.6	
Gestational Age by TCD							
Accurate	23	92.0	31	93.9	29	90.6	0.882
Inaccurate	2	8.0	2	6.1	3	9.4	

DISCUSSION

As regard demographic data of the studied group. Age ranged from 20-40 years with a mean value 29.90±6.113 years. BMI ranged from 21.1-33.9 kg/m2 with a mean value of 26.52±2.557 kg/m2. More than half of the studied sample was from urban places (61.1%). More than half of the studied sample had multi gravida (57.8%).

Our results were supported by the study of *Rajendra (2019)* as they reported that age of women ranged from 18 to 42 years with maximum number of patients aged 15-20 years (20%) followed by those aged 16-20 years (22%), 26 to 30 (18%),31-35 weeks (17%) and>36 years (14%). Similarly, parity wise distribution shows highest reported cases are of gravid 2.

In the study of *El-Sayed et al. (2021)*, maternal age (years) was distributed as 31.84±6.96 and 31.33±6.09 respectively between Normal and IUGR with no significant difference. BMI (kg/m2) was 26±2.6 and 28±2.9 respectively between normal and IUGR with no significant difference. There was no significant difference between groups regard gestational age. There was no significant difference regard parity and fetal sex.

The present study showed that gestational age by LMP of the studied group ranged from 14-40 weeks with a mean value 26.36±8.073 weeks.

Our results were supported by the study of *Reddy et al. (2017)* as they reported that mean GA based on LMP was 21.13 weeks in second trimester and 34.37 weeks in third trimester. Total mean GA was 27.75 weeks.

In the study of *Dashottar et al. (2018)*, the studied group was divided as per the week of gestational age (as per LMP or as mentioned in the requisition form). Gestational age of cases ranged from 15 weeks 6 days to 38 weeks 2 days. Maximum number of cases were in gestational age >32- 36 weeks (33.5%) followed by those in 16-20 weeks (23.5%), >20-25 weeks (17%) and >28-32 weeks (12.5%) respectively. Cases with gestational age >24-28 weeks and >36-40 weeks comprised only 7.5% and 6% of study population respectively.

Pathological alteration in fetal growth pathway due to macrosomia or IUGR does not seem to affect TCD even changes in

vault development due to external pressure did not alter TCD. Different tools have been used to study reliably and clarify cerebellar growth and normal morphological development through various imaging tools such as 2D ultrasound, MRI and even postmortem examination, including histological studies to reflect accurate development at microscopic and macroscopic level. All these tools confirmed reliability of TCD to estimate gestational age *(Uikey et al., 2016)*.

The present study showed that gestational age by TCD in women with gestational age ranged between 14 – 20 weeks group was ranged between 13-20 weeks with mean± S.D. 16.24±2.067 weeks, while in women with gestational age ranged between 21 – 29 weeks group ranged between 20-28 weeks with mean± S.D. of 24.67±2.746 weeks, and in women with gestational age ranged between 30 – 40 weeks group ranged between 29-40 weeks with mean± S.D. 34.91±3.373 weeks with statistically significant differences on comparing with gestational age by LMP. Gestational age by TCD in women with gestational age was accurate in 84% of patients while in women with gestational age ranged between 21 – 29 weeks group was accurate in 51.5% of patients, and in women with gestational age ranged between 30 – 40 weeks group was accurate in 53.1% of patients with statistically significant differences between groups.

Our results were in line with study of *Eze et al. (2020)* as they reported that the mean TCD was 32.0 ± 11.6 mm; TCD had a strong positive linear relationship with GA. The GA that was estimated using regression models, which were derived using the sonographic ally measured TCD, was closer to the actual GA in the second and third trimesters of pregnancy than the GA estimated using other fetal parameters.

A study conducted by *Davies et al. (2010)* verified the relationship between GA and TCD to identify the prediction of GA by TCD in addition to the evaluation of the reliability of TCD measurements. They found that TCD correlates strongly with GA and expected the GA to 9.16±2.33 weeks. Measurements of TCD had excellent reproducibility.

A study was carried out by *Goel et al. (2010)* on antenatal subjects (20–40 years of age) between 14 and 40 weeks of pregnancy attended to the clinic for routine ultrasound examination. Measurement of Ultrasonography of TCD was performed to assess the gestational age. The regression analysis indicated a significant relationship between TCD and GA, indicating that TCD is a good marker for the estimation of GA.

Ahmed (2014) evaluated the accuracy of fetal trans cerebellar diameter nomogram in the prediction of gestational age in singleton gestation at the second and the third trimesters of singleton pregnancy. He found that the TCD measurement appears to be an accurate predictor of gestational age, even in the third trimester of pregnancy. It is recommended to use TCD as an important ultrasound biometric parameter in normal singleton for the prediction of gestational age.

A study was established that TCD measurement was both reliable and accurate in predicting gestational age even

in extremes of fetal growth. While majority of data suggests that the TCD is extremely valuable when the gestational age is unknown or IUGR is suspected *(Chavez et al., 2010)*.

Previous studies had found a close correlation between cerebellar dimensions and GA using fetal growth parameters including BPD, head circumference, FL, and estimated fetal weight, this relationship had been found to be independent on fetal gender *(Holanda-Filho et al., 2011)*.

In the study of *Ali et al. (2019)*, the results showed that the trans cerebellar diameter (TCD) is more accurate than the biparietal diameter (BPD). There was insignificant statistical difference between trans cerebellar diameter (TCD) and femur length (FL) for determination of gestational age in the third trimester whereas there was a significant difference between the trans cerebellar diameter (TCD) and the biparietal diameter (BPD) for determination of gestational age in the third trimester. All those data were compared to the last menstrual period.

According to *El-Sayed et al. (2021)*, there was a statistically significant difference between gestational age (GA) by Last Menstrual Period (LMP) and sonar parameters at normal group but highest was TCD. In IUGR group, TCD, AC and FL were significantly positive correlated with GA; and TCD were significant.

Akl et al. (2014) performed a research in Egypt conducted in the third trimester of pregnant women to evaluate the accuracy of TCD in the assessment of gestational age, and concluded that TCD is a reliable tool for assessing gestational age in the third trimester of pregnancy.

In the study of *El-Ebeisy et al. (2019)*, accuracy of measured gestational age according to measured parameters in relation to actual gestational age (accuracy within 2 weeks), TCD had the highest accuracy (98.7%) than other parameters in early second trimester. Accuracy of TCD in late second trimester was 91.6% and 82% in early third trimester while in late third trimester TCD had the lowest accuracy (68.1%).

Bansal et al. (2014) reported that parameter which correlated most with gestational age is trans cerebellar diameter. In the normally developing fetus, the trans cerebellar diameter increases with advancing gestational age. Trans cerebellar diameter is a good marker for gestational age and can be used in cases that are not sure about the dates. *Nagesh et al. (2016)* demonstrated that a linear relationship was found between TCD and fetal gestational age between 15 to 40 weeks of normal gestation.

Furthermore, *Mandal et al. (2019)* observed that there was a statistically significant curvilinear relationship between TCD and gestational age in normal pregnancies. The growth pattern of cerebellum followed a second degree polynomial similar to that of BPD and FL. Gestational age estimated by TCD correlated well with the estimated gestational age by BPD and FL.

CONCLUSION

Trans-cerebellar diameter was more reliable method of gestational age determination in third trimester of pregnancy than biparietal diameter. Trans-

cerebellar diameter (TCD) and femur length (FL) can be used as a tool to assist in the assessment of gestational age in third trimester.

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دقة قطر المخيخ في حساب عمر الحمل مقارنة بقياسات الحمل الأخرى في الثلث الثاني والثالث من الحمل

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خلفية البحث: يعد التحديد الدقيق لعمر الحمل أحد أكثر التقييمات المفيدة للحمل، والذي يعتمد في البداية على ما إذا كانت المريضة حاملًا أم لا.

الهدف من البحث: تقدير عمر الحمل باستخدام قطر المخيخ العابر مقارنة بطول عظم الفخذ وقطر بين الجداريين في الثلث الثاني والثالث من الحمل وفقًا لليوم الأول من آخر دورة شهرية.

المريضات وطرق البحث: أجريت دراسة استباقية شملت 90 امرأة حاملاً. وقد تم إختيار جميع الحالات من قسم النساء والولادة بمستشفى سيد جلال للحصول على رعاية ما قبل الولادة والموجات فوق الصوتية الروتينية في الفترة من نوفمبر 2020 حتى يونيو 2021. أما مجموعة الدراسة فقد تم تقسيمها إلى ثلاث مجموعات: المجموعة 1: 14-20 أسبوعًا (أوائل الثلث الثاني من الحمل). والمجموعة الثانية: 21-29 أسبوعًا (أواخر الجزء الثاني من الحمل). والمجموعة 3: 30-40 أسبوعًا (الثلث الثالث من الحمل).

نتائج البحث: كان عمر الحمل بواسطة قطر المخيخ العابر في النساء ذوات عمر الحمل دقيقًا في 92٪ من المريضات بينما في النساء اللواتي تراوحت أعمارهن بين 21 و 29 أسبوعًا كانت

النتائج دقيقة في 93.9٪ من المريضات وفي النساء اللواتي تراوحت أعمارهن بين 30-40 أسبوعًا كانت النتائج دقيقة في 90.6٪ من المريضات مع عدم وجود فروق ذات دلالة إحصائية بين المجموعات.

الاستنتاج: قطر المخيخ العابر هو طريقة أكثر موثوقية لتحديد عمر الحمل في الثلث الثالث من الحمل من القطر الثنائي. ويمكن إستخدام قطر المخيخ العابر وطول عظم الفخذ كأداة للمساعدة في تقييم عمر الحمل في الثلث الثالث من الحمل.

الكلمات الدالة: عمر الحمل، داخل الرحم، قطر عبر المخيخ، ثنائي الجنين، الحمل.