

## Evaluation of Third Trimester Gestational Age Using Fetal Maximum Transverse Cerebellar Diameter

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Abstract:

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**Objectives:** The aim of this study was to evaluate whether trans-cerebellar diameter (TCD) in singleton gestations can serve as a reliable predictor of gestational age (GA) in fetuses in the third trimester between 31-36 weeks of pregnancy in women attending the antenatal care clinic for routine ultrasound examination. **Patients and Methods:** This was a prospective observational study conducted on pregnant women attending our ultrasound unit for routine antenatal care at Benha University Hospital. The study was conducted after obtaining approval from Local Ethics Committee on research involving human subjects of Benha Faculty of Medicine from December 2021 to October 2022. **Results:** There was statistically significant positive correlation between GA by LMP with GA by BPD and GA by TCD, GA by FL as well as GA by AC. TCD had highest correlation with value of 0.969. There was statistically significant positive correlation between GA by TCD with GA by LMP and GA by BPD, GA by FL as well as GA by AC. **Conclusion:** According to the study, TCD is the most accurate method for determining gestational age in the third trimester, followed by FL, and BPD is the least accurate. Additionally, even in cases where patients are unaware of their dates, we may be fairly positive of gestational age by combining the accuracy of TCD (89%) and FL (79%).

**Keywords:** Trimester; Gestational Age; Fetal Maximum Transverse Cerebellar Diameter

## Introduction

Gestational age (GA) estimation is one of the most important decisions during antenatal care. It is the basis for the appropriate timing of deliveries and management of complications. Decisions based on inaccurate gestational ages result in higher fetal and maternal morbidity and mortality (1).

The most commonly used fetal parameters are biparietal diameter, head circumference, abdominal circumference and femur length. In the first trimester, the ultrasound assessment of gestational age is the most accurate. The ultrasound accuracy is reduced in the second trimester and markedly reduced in the third trimester. Recently, studies have shown that fetal transcerebellar diameter is the most precise ultrasound parameter for estimation of the gestational age (2).

Using the last menstrual period (LMP) as a method of gestational age estimation is affected by regularity of the cycles, using hormonal contraception and absence of accurate records in developing countries which makes this method challenging (3).

Sonographic estimation of gestational age is the 'gold standard' in antenatal care, with the first-trimester measurement of crown-rump-

length (CRL) which is considered the most reliable index (4).

The most frequently used fetal biometric parameters after the first trimester include the biparietal diameter (BPD), femur length (FL) and abdominal circumference (AC) (3).

Unlike the AC, the transcerebellar diameter (TCD) is little affected in cases of fetal growth restrictions; hence, the GA can be predicted accurately with the TCD even in the 3rd trimester. In developing countries, many women come for the first time to the hospital in the 3rd trimester and do not remember their LMP well, so it is difficult to estimate the GA of the fetus.

With the advantages of the TCD over other fetal biometric parameters, this study evaluated the accuracy of TCD measurements for the estimation of GA and compared it with other ultrasound parameters used routinely for gestational dating, including the BPD, AC, and FL, in the 3rd trimester of normal singleton pregnancies in women whose gestational age was known by early pregnancy gestational dating scans of up to 14 weeks (5).

## Patients and Methods

This was a prospective observational study conducted on pregnant women attending our ultrasound unit for routine antenatal care at Benha University Hospital. The study was conducted after obtaining approval from Local Ethics Committee on research involving human subjects of Benha Faculty of Medicine from December 2021 to October 2022 under the code # MS 9-11-2021.

**Sample Size:** Women were recruited from obstetrics outpatient clinic while attending for routine antenatal care between 31 to 36 weeks. Total 103 women were examined for this study

The sample size calculated according to equation:  $N = 4\sigma^2 (Z_{crit} + Z_{power})^2 / D^2$ .  
 $N$  = Total sample size which is the sum of the sizes of both comparison groups.  $\sigma$  = the standard deviation of each groups, assumed to be equal in both groups=1.  $Z_{crit}$  = the desired significance criterion =0.05.  $Z_{power}$  = Desired statically power. =80%.  $D$  = the minimum expected difference

The calculation showed that we should include at least 100 women to achieve study power of 80%.

Women in the age range from 18 to 40 years old, with healthy singleton pregnancy at 31-

36 weeks gestation (calculated by the first day of last menstrual periods and confirmed by 1<sup>st</sup> trimester ultrasound scan) were included

**Inclusion criteria:** Singleton uncomplicated pregnancy at third trimester, Sure date of last menstrual period, viable fetus in the cephalic presentation and history of regular menstrual cycles at least three cycles before pregnancy.

**Exclusion Criteria:** Patients unsure of their dates or no reliable dates, irregular cycles, medical disorders with pregnancy as hypertension, diabetes mellitus and Rh iso-immunization, prelabor rupture of membranes, polyhydramnios, multiple pregnancy, congenital fetal anomalies, intrauterine fetal death and intra uterine growth retardation.

**Methods:** All participants were subjected to:

- **History taking:** Gestational age of all women was confirmed by menstrual period and first trimester ultrasonography and maternal medical history during pregnancy.
- **Clinical examination:** General Examination: Vital signs (Blood pressure, Temperature, pulse rate),

abdominal Examination: Physical examination and local Examination: Fundal level

- **Laboratory investigations:** Complete blood count, blood grouping and Rh and random blood sugar and urine analysis
- **Ultrasound examination for:** Biparietal Diameter, femur Length and trans-Cerebellar Diameter

### **Procedure:**

All patients were examined using transabdominal ultrasound while lying in a supine position with the head of the bed raised 30 degrees and a little pillow under the right loin. The Voluson 730 ProV (General Electric Company) ultrasound equipment was employed, which included a Doppler unit and a 3.5 MHz convex linear transducer. A transverse view of cerebral anatomy through the posterior fossa was used to quantify transcerebellar diameter, which included visibility of the midline thalamus, cerebellar hemisphere, and cisterna magna. The measurements were taken using ultrasound machine screen calipers at the cerebellum's outer edges (6).

The biparietal diameter was measured in the lateral ventricles view, which revealed a rugby-football-shaped skull with a rounded

rear (occiput) and a more pointed front (sinciput), along the midline, about halfway between the proximal and distal scale echoes. One-third of the way between the sinciput and the occiput, the cavum septum pellucidum bisected the midline. The lateral ventricles' two anterior horns are symmetrically located around the midline. The posterior horns of the lateral ventricles, all or part of them, are symmetrically distributed around the midline. Only the thickness of the top parietal bone is included in the BPD (outer to outer measurement) (7).

The FL is imaged optimally for femur length measurement, with both ends of the ossified metaphysis plainly visible. The ossified diaphysis's longest axis is measured. When calculating the angle between the femur and the insonating ultrasound beams, apply the same method as when creating the reference chart. Insonation angles of 45 to 9 degrees are common. Each measurement is positioned at the ends of the ossified diaphysis, excluding the distal femoral epiphysis if it is visible, in terms of probe placement. Triangular spur that might artificially expand the diaphysis length should be excluded from this measurement. Within 3 days and 1 week from the actual gestational age determined by LMP or first trimestric ultrasound, the percentages of

accurate gestational age assessment by the three measures (TCD, BPD, and FL) were computed (8).

**Statistical analysis:** The collected data will be, tabulated, and statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 26.0, Microsoft Excel 2016 and MedCalc program software version 19.1. Inferential analyses were done for quantitative variables using independent t-test in cases of two independent groups with parametric data and Mann Whitney U in cases of two independent groups with non-parametric data.

## RESULTS

This prospective observational study was carried out on 103 pregnant women attending from obstetrics outpatient clinic for routine antenatal care at Benha University Hospital between 31 to 36 weeks.

The mean age of pregnant women in the study was  $30.22 \pm 4.49$  years with minimum age of presentation being 19 years and maximum being 40 years. the most frequent group represented was age group of 31- 40 years in 59.2% women. The Body mass index (BMI) ranged from 25 Kg/m<sup>2</sup> to 31 Kg/m<sup>2</sup> with mean of  $28.67 \pm 1.93$  Kg/m<sup>2</sup>. The mean parity was  $2.44 \pm 1.19$  with 7.8%

were primigravida and 92.2% were multigravida (**Table 1**).

The mean Bi-parietal Diameter was  $83.055 \pm 3.688$  mm while the mean femur length was  $65.041 \pm 3.46$  mm. The abdominal circumference was  $286.078 \pm 15.738$  mm. The mean Trans-Cerebellar Diameter of studied cases was  $40.669 \pm 2.349$  mm (**Table 2**).

The mean gestational age (GA) measured by LMP was  $32.83 \pm 1.34$  weeks. The mean GA measured by BPD was  $32.02 \pm 3.46$  weeks while the mean GA measured by TCD was  $33.10 \pm 3.34$  weeks. The mean GA measured by FL was  $32.94 \pm 3.48$  weeks and the mean GA measured by AC was  $32.61 \pm 1.72$  weeks (**Table 3**).

The mean change of G.A by TCD, FL, BPD and AC from G.A of LMP was  $2.37 \pm 2.77$ ,  $4.94 \pm 5.4$ ,  $7.67 \pm 6.30$  and  $6.71 \pm 4.07$  respectively. It was observed that the mean gestational age (GA) measured by TCD showed the least change from G.A measured by LMP, this means that G.A by TCD was the most accurate and ant its results had concordance with G.A measured by LMP (**Table 4**).

In our study we found that out of 103 patients, the TCD gave the most correct assessment of gestational age within 3 days

in 73 patients (70.87%) and within 1 week in 91 patients (88.35%). While the FL gave correct assessment of gestational age within 3 days in 50 patients (48.54%) and within 1 week in 81 patients (78.64%). The BPD gave correct assessment of gestational age within 3 days in 35 patients (33.98%) and within 1 week in 60 patients (58.25%). The least accurate was the AC that gave correct assessment of gestational age within 3 days in 30 patients (29.13%) and within 1 week in 47 patients (45.63%) (**Table 5**).

There was statistically significant positive correlation between GA by LMP with GA by BPD ( $r=0.682$ ,  $p<0.001$ ) and GA by TCD

( $r=0.969$ ,  $p<0.001$ ), GA by FL ( $r=0.695$ ,  $p<0.001$ ) as well as GA by AC ( $r=0.860$ ,  $p<0.001$ ). TCD had highest correlation with value of 0.969 (**Figure 1, 2**).

There was statistically significant positive correlation between GA by TCD with GA by LMP ( $r=0.969$ ,  $p<0.001$ ) and GA by BPD ( $r=0.698$ ,  $p<0.001$ ), GA by FL ( $r=0.722$ ,  $p<0.001$ ) as well as GA by AC ( $r=0.843$ ,  $p<0.001$ ) (**Figure 3, 4**).

This table shows: linear regression analysis between LMP and other parameters. It was noticed that TCD was the most important predictors for G.A. (**Table 6**).

**Table (1):** Distribution of demographic characteristics among the studied women

Parameters	Studied women (n=103)		
	N	%	
Age groups	≤ 20 years	4	3.9%
	21- 25 years	10	9.7%
	26- 30 years	28	27.2%
	31- 40 years	61	59.2%
Age (years)	Mean± SD	30.22± 4.49	
	Median	32.0	
	Range	19.0- 40.0	
BMI (Kg/m <sup>2</sup> )	Mean± SD	28.67± 1.93	
	Median	29.0	
	Range	25.0 – 31.0	
Parity	Mean± SD	2.44± 1.19	
	Median	2.0	
	Range	0.0 – 5.0	
	primipara	8	7.8%
Multipara	95	92.2 %	

*SD= standard deviation,*

**Table (2):** Distribution of patients as regard to ultrasound measures

	Studied women (N= 103)				
	Mean	±SD	Median	Minimum	Maximum
<b>BPD (mm)</b>	83.055	3.688	83.2	71.7	92.3
<b>FL (mm)</b>	65.041	3.46	64.2	57.1	73.3
<b>AC (mm)</b>	286.078	15.738	284	262	325
<b>TCD (mm)</b>	40.669	2.349	40	37.4	46.2

*SD= standard deviation, AC: Abdominal circumference, TCD:Trans-Cerebellar Diameter,*

*BPD: Biparietal Diameter, FL:Femur Length*

**Table (3):** Distribution of patients as regard gestational age measured by different parameters

	Studied women (N= 103)				
	Mean	±SD	Median	Minimum	Maximum
<b>G.A- LMP</b>	32.83	1.34	33.00	31.00	36.00
<b>G.A- BPD</b>	33.02	3.46	33.29	3.50	38.57
<b>G.A- TCD</b>	33.10	3.34	32.86	3.30	36.71
<b>G.A- FL</b>	32.94	3.48	33.14	3.50	37.57
<b>G.A- AC</b>	32.61	1.72	32.14	30.14	36.86

*GA: Gestational age, SD: standard deviation, LMP: Last menstrual period, AC: Abdominal circumference, TCD: Trans-Cerebellar Diameter, BPD: Biparietal Diameter, FL: Femur Length*

**Table (4):** Delta change between GA measured by LMP and GA estimated by ultrasound parameters

Δ G.A Change	Studied women (N= 103)				
	Mean	±SD	Median	Minimum	Maximum
<b>G.A- TCD</b>	2.37	2.77	1.00	.00	9.00
<b>G.A- FL</b>	4.94	5.4	4.00	.00	33.00
<b>G.A- BPD</b>	7.67	6.30	7.00	.00	34.00
<b>G.A- AC</b>	6.71	4.07	8.00	.00	20.00

**Table (5):** Correct assessment of GA estimated by ultrasound parameters compared to GA measured by LMP.

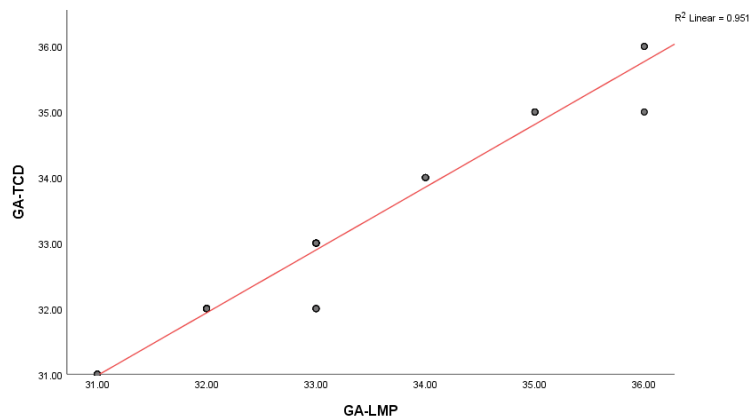
		Correct		Incorrect	
		N	%	N	%
GA by TCD	In 3 days	73	70.87%	30	29.13%
	In 1 week	91	88.35%	12	11.65%
GA by FL	In 3 days	50	48.54%	53	51.46%
	In 1 week	81	78.64%	22	21.36%
GA by BPD	In 3 days	35	33.98%	68	66.02%
	In 1 week	60	58.25%	43	41.75%
GA by AC	In 3 days	30	29.13%	73	70.87%
	In 1 week	47	45.63%	56	54.37%

*P value < 0.05 is significant, P value < 0.01 is highly significant, SD: Standard deviation,*

**Table (6):** Multiple linear regression analysis for GA measured by LMP and GA estimated by ultrasound parameters

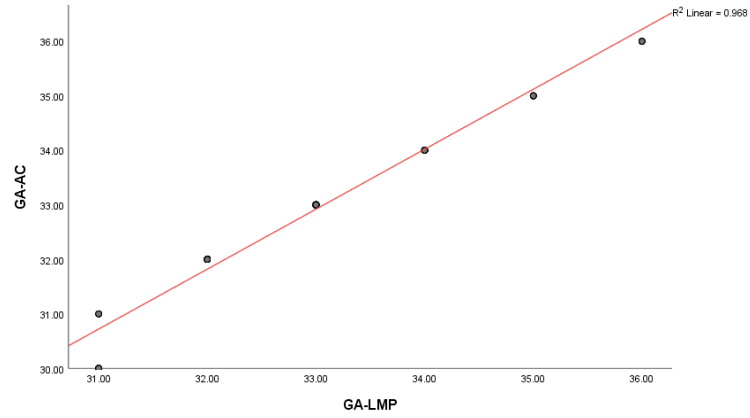
	Unstandardized Coefficients		Standardized Coefficients	t	p- value
	B	Standard error	Beta		
(Constant)	0.262	0.496		0.529	0.598
GA-BPD	0.087	0.042	0.069	2.076	<b>0.041</b>
GA-TCD	0.425	0.041	0.475	10.440	<b>&lt;0.001</b>
GA-FL	0.333	0.043	0.327	7.662	<b>&lt;0.001</b>
GA-AC	0.153	0.038	0.148	4.030	<b>&lt;0.001</b>

*B: Regression coefficient; S.E: Standard error*

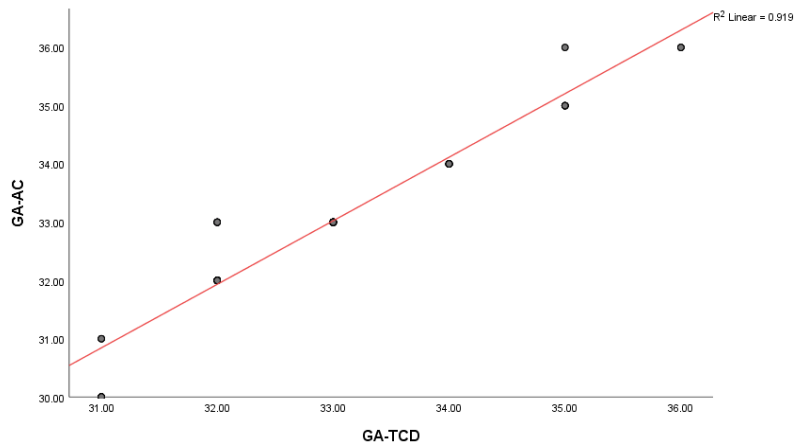


**Fig. (1):** Scatter plot showing positive correlation between GA by LMP with GA by TCD

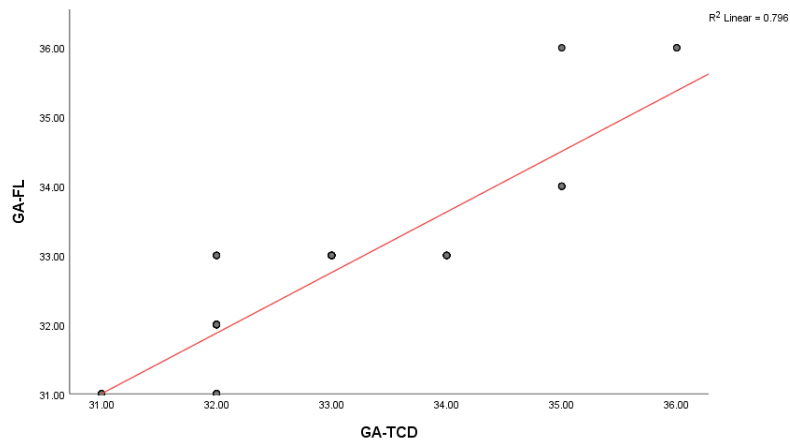




**Fig. (2):** Scatter plot showing positive correlation between GA by LMP with GA by AC



**Fig. (3):** Scatter plot showing positive correlation between GA by TCD with GA by AC.



**Fig. (4):** Scatter plot showing positive correlation between GA by TCD with GA by FL.

## Discussion

The determination of gestational age is important in obstetrics for management of pregnancy and evaluation of fetal development.

In our study had been found that out of 103 patients, the TCD gave the most correct assessment of gestational age within 3 days in 73 patients (70.87%) and within 1 week in 91 patients (88.35%). While the FL gave correct assessment of gestational age within 3 days in 50 patients (48.54%) and within 1 week in 81 patients (78.64%). The BPD gave correct assessment of gestational age within 3 days in 35 patients (33.98%) and within 1 week in 60 patients (58.25%). The least accurate was the AC that gave correct assessment of gestational age within 3 days in 30 patients (29.13%) and within 1 week in 47 patients (45.63%).

Numerous studies had demonstrated that TCD is a more useful growth-assessing tool than other popular ultrasonography parameters and has a greater relationship with gestational age in the second and third trimesters (15).

In this work it had been found that TCD is an accurate approach for determining gestational age in the third trimester of pregnancy. The importance of this study was

highlighted by the fact that many patients in our nation, particularly those from low socioeconomic backgrounds, visit the hospital without having a medical history or having previously received antenatal care. They also frequently forget their LMP or EDD, which makes it very challenging for the doctor to determine the gestational age of the fetus. Uncertain gestational age has been linked to poor pregnancy outcomes, such as macrosomia, low birth weight, preterm delivery, and perinatal mortality.

Using ultrasound to investigate the prenatal cerebellum development can assist evaluating the gestational age of the fetus in a study. They demonstrated a strong correlation between TCD and gestational age. Transverse cerebellar diameter is a reliable indicator of gestational age and can be used in circumstances where the LMP is uncertain. Throughout gestation, they provided readings within the cerebellar normal range. These numbers might make it possible to evaluate the posterior fossa and cerebellar development intrauterine.

To determine the accuracy of transverse cerebellar diameters in estimating gestational age, taking LMP as the gold standard was done. A total of 114 patients

were included in the study. Ultrasonographic measurement of Transverse Cerebellar Diameter (TCD) was taken. Routine measurements of crown-rump length or bi-parietal diameter were also done. Accuracy was considered if the difference between TCD and LMP was  $\leq 2$  mm. Correlation of age on LMP with TCD was tested using Kendall's tau-b test and its scatter plot as generated. Transverse cerebellar diameter was found to be equally good and relatively comparable with LMP in predicting gestational age (10).

The reliability of the transverse cerebellar diameter (TCD) had been studied in predicting gestational age (GA) in fetuses between 14 and 40 weeks of pregnancy. The participants were split into two groups (14-27 weeks and 28 to 42weeks). The study observed that TCD is a reliable metric for estimating gestational age since its values closely resemble those of GA as determined by LMP. When compared to other metrics, TCD is a stronger predictor of gestational age, especially between (14-22) weeks. From the second to the third trimester, there seems to be less of a correlation between the gestational age calculated by LMP and the gestational age calculated by TCD. Age and parity of the mother have no impact in TCD (11).

The accuracy of the TCD in estimating gestational age was examined by another study using 150 pregnant women in their third trimester in Egypt. He came to the conclusion that the TCD is an accurate approach for estimating gestational age in the third trimester of pregnancy (12).

Fetal Transcerebellar Diameter (TCD) was used to examine the accuracy of predicting GA and to compare TCD and other existing metrics in evaluating GA in 15 to 40 weeks of gestation. They demonstrated that because TCD levels are closely correlated with GA by LMP, it is an accurate criterion for estimating gestational age in the second and third trimesters. When it was compared to other metrics, especially in the third trimester, it is also a better predictor of the gestational age (9).

One study had compared the accuracy of biparietal diameter and transcerebellar diameter in measuring the gestational age during the third trimester of pregnancy. In this prospective observational study, 275 pregnant women with singleton pregnancy between 32 and 37 weeks gestational age were recruited. There was a strong positive correlation between gestational age and transcerebellar diameter ( $r = 0.98, p < 0.001$ ) as well as biparietal diameter ( $r = 0.87, p < 0.001$ ), yet a stronger correlation

was with transcerebellar diameter. 93.6% of gestational age assessment by transcerebellar diameter was correct compared to only 79.9% by biparietal diameter (13).

Another study had shown TCD as a reliable single method for estimating GA. Total number of 257 healthy pregnant Igbo women with singleton normal pregnancies with GAs between 16 and 40 weeks made up the sample. GA was estimated using the biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), with GA being computed from the day of the previous menstrual period's onset (LMP) as the standard criterion. TCD was quantified and used to create regression models that were then used to evaluate GA. The sonographically measured TCD was more reliable as a single estimator of GA in the late stages of pregnancy than BPD, HC, AC, and FL in a group of healthy pregnant women of Igbo ethnic background living in Oshodi, Lagos State, Nigeria (14).

The study's limitations had included its small sample size (103 cases) and the fact that, in order to assess the reliability of transcerebellar diameter in estimating gestational age using the date of the last menstrual period as the gold standard, many

cases with irregular cycles and cases where the date of the last menstrual period was uncertain were excluded.

## **Conclusion:**

According to the study, TCD is the most accurate method for determining gestational age in the third trimester, followed by FL, and BPD is the least accurate. Additionally, even in cases where patients are unaware of their dates, we may be fairly positive of gestational age by combining the accuracy of TCD (89%) and FL (79%).

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