

**Estimation of Gestational Age by Transcerebellar Diameter and Its Comparison with Biparietal Diameter, Head Circumference, Abdominal Circumference and Femur Length in Normal Singleton Pregnancy.**

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**Abstract**

Estimation of gestational age by transcerebellar diameter and its comparison with biparietal diameter, head circumference, abdominal circumference and femur length in normal singleton pregnancy.

**Introduction** Precise determination of gestational age in antenatal period is necessary for the management of pregnancies. In contemporary obstetric practice use of sonography is the most reliable and effective way for assessment of gestational age. Transcerebellar diameter is an emerging alternative marker for gestational age estimation. The present study was undertaken to estimate gestational age by transcerebellar diameter in normal pregnancy between 18 to 36 weeks and its comparison with other foetal biometric measurements.

**Methodology** It was a hospital based, prospective cross-sectional study over a period of 6 months from October

2018 to March 2019. 150 women with normal singleton pregnancies between 18 to 36 weeks of gestation were included in the study after obtaining consent. Ultrasound measurements of TCD, BPD, HC, AC and FL were done. Data were analyzed statistically.

**Results** Regression analysis between TCD and gestational age shows a linear relationship. The correlation coefficient between TCD & GA was 0.9684 and p value <0.0001. Regression analysis between TCD and other parameters (BPD, HC, AC and FL) shows significant linear relationship with correlation coefficient 0.9414, 0.9493, 0.9648 and 0.9576 respectively and p value <0.0001.

**Conclusion:** A linear relationship between TCD and gestational age was observed indicating the reliability in the estimation of gestational age and monitoring fetal growth. We recommend that TCD be used as an important

sonographic biometric parameter in fetuses for accurate prediction of GA.

**Keywords:** Transcerebellar diameter, ultrasonography, biparietal diameter, head circumference, abdominal circumference, femur length, gestational age

### Introduction

Precise determination of gestational age in antenatal period is necessary for the management of pregnancies. An error in the estimation of gestational age (GA) may be associated with preterm delivery, low birth weight and post maturity along with higher perinatal and maternal mortality and morbidity. [1-6]

Clinically estimation of gestational age depends on history i.e. menstrual cycle length, regularity of menstrual cycle and first day of the last menstrual period followed by examination and fundal height. In contemporary obstetric practice use of sonography is the most reliable, accurate and effective way for assessment of gestational age, especially during the first half of pregnancy. [1] Sonography is also extensively used for detailed assessment of foetal anatomy, detection of major congenital anomalies, fetal growth and wellbeing.[1,3,7] Commonly used sonographic fetal parameters include crown - rump length (CRL), biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC).[4] The accurate measurement of these parameters depends a lot on fetal lie, shape of skull, location of placenta, flexion of fetal head and engagement, maternal obesity and multiplicity of gestation. More recently another fetal parameter, transcerebellar diameter (TCD) has evolved as a promising indicator for assessing fetal growth and gestational age.[8,9]

Sonographic foetal biometry is reliable in first two trimesters. However, in third trimester, no single

parameter is reliable in estimating accurate gestational age, as each of them got a discrepancy of more than 3 weeks and its reliability diminishes as the gestation advances. [1] Size of cerebellum is less affected by deviation in fetal growth restriction or growth acceleration. [8] The predicted gestational age by TCD between 22 – 28 weeks is within 0-2 days, between 29 - 36 weeks is within 05 days and at 37 week is 09 days of actual gestation. TCD normogram predicts gestational age with accuracy of 94% in the third trimester. [10]

Naseem F et al in their study observed that TCD and BPD both can predict gestational age accurately at 36 weeks but TCD was more reliable method of gestational age determination in third trimester of pregnancy.[11] Very few studies have been done in our state using TCD for gestational age estimation so the present study was undertaken to estimate gestational age using transcerebellar diameter by ultrasonography in normal pregnancy between 18 to 36 weeks and to compare TCD with other foetal biometric measurements such as BPD, HC, AC and FL.

### Material and Methods

**Study design:** It was a hospital based, prospective cross-sectional study over a period of 6 months from October 2018 to March 2019. 150 women with normal singleton pregnancies between 18 to 36 weeks of gestation were included in the study after obtaining consent.

**Inclusion criteria:** women with singleton viable normal pregnancy between 18 to 36 weeks of pregnancy with previous regular menstrual period and known last menstrual period (LMP)

**Exclusion criteria:** Women with medical disorders, IUGR and with congenital malformation of the foetus.

Gestational age was assessed by LMP. Ultrasound measurements of TCD (in mm) were made as per

operational definition with commercially available real time ultrasound. The measurement of TCD was obtained by placing electronic callipers at outer margins of cerebellum. The landmarks of the thalami, cavum, septum pellucidum and third ventricle were identified thereby slightly rotating the transducer below the thalamic plane. The posterior fossa is revealed with the characteristics butterfly like appearance of cerebellum. In all cases cerebellum was seen as two lobules on either side of midline in the posterior cranial fossa.

Biparietal diameter was measured in transverse plane at the level of thalami from the outer table of proximal skull to the inner table of distal skull corresponding to the leading edge to edge measurement. HC was measured on the same section as for the BPD. The circumference was directly measured on the screen using electronic calipers to the circumference. AC was measured at the level of the fetal liver using a cross-sectional view that included visualisation of intrahepatic portion of the umbilical vein and stomach bubble and non-visualisation of kidneys. For FL measurement, the longest axis of ossified femoral diaphysis was measured. The measurement was made of the shaft only, excluding the unfused epiphysis.

Statistical analysis: The data were entered in Microsoft excel sheet and analyzed statistically. Pearson correlation coefficient “r” was calculated for various parameters (TCD, BPD, HC, AC, FL) and GA. Pearson correlation coefficient “r” was also calculated for TCD and other foetal parameters (BPD, HC, AC and FL). P value  $\leq 0.05$  was considered significant.

## Results

The present study was conducted in the Department of Obstetrics and Gynaecology, S.M.S. Medical College, Jaipur. A total of 150 pregnant women were included in

the study after applying inclusion and exclusion criteria.

TCD and other foetal parameters were measured.

Table 1 shows the demographic characters of the participants. The mean age of the women was  $27.93 \pm 4.22$  years with a range of 19 years to 42 years. Mean BMI of the women was  $23.97 \pm 4.08 \text{ Kg/M}^2$ . The BMI ranged from 16.6 to  $38.2 \text{ Kg/M}^2$ . 61.3% women were primigravida. Gravidity ranged from gravida 1 to gravid 6 and a mean gravidity was  $1.48 \pm 0.90$ . Mean gestational age was  $25.07 \pm 5.51$  weeks with a range of 18 to 36 weeks.

Table 2 shows mean TCD at gestational age from 18 to 36 weeks. Mean TCD at 18 weeks of pregnancy was  $18.06 \pm 0.59$  mm and at 36 weeks it was  $40.5 \pm 1.56$  mm. The TCD increases with increase in gestational age. It was also observed that mean TCD in mm is equal to gestational age in weeks during 18-24 weeks then it gradually increased and there was more than two-fold increase in mean TCD from 18 weeks to 36 weeks.

Table 3 and Figure 1 shows mean TCD, BPD, HC, AC and FL at different gestational age between 18 to 36 weeks. All parameters showed a linear relation with increasing GA.

Table 4 shows the descriptive of sonographic fetal biometry in included women. Median of BPD was 55.75 mm with inter quartile Range (IQR) 49.48 – 74.87 mm. Median of HC was 208.2 mm with inter quartile Range (IQR) 182.88 – 272.8 mm. Median of AC was 167.25 mm with inter quartile Range (IQR) 149.45 – 243.78 mm. . Median of FL was 40.75 mm with inter quartile Range (IQR) 34.2 – 55.8 mm. Median of TCD was 22.85 mm with inter quartile Range (IQR) 20.1 – 32.43 mm.

Table 5 shows the correlation between fetal biometric parameters and gestational age. Like other routine

parameters, TCD was also significantly positively correlated to gestational age.

Regression analysis between TCD (X axis) and gestational age (Y axis) shows a linear relationship. (Figure 2) The formula obtained was  $Y = 0.7444 * X + 5.718$  (Y = gestational age, X = transcerebellar diameter). The correlation coefficient between TCD & GA was 0.9684 and p value <0.0001 (which was statistically significant).

Regression analysis between TCD and BPD, TCD and HC, TCD and AC, and TCD and FL shows significant linear relationship with correlation coefficient 0.9414, 0.9493, 0.9648 and 0.9576 respectively and p value <0.0001. (Figure 3, Figure 4, Figure 5 and Figure 6)

### Discussion

The accurate estimation of gestational age is essential for management of pregnancy. It is required to decide the timing and method of delivery in high risk pregnancies. The methods used to estimate gestational age are menstrual history, clinical examination, perception of foetal movements and nagele's rule.[7] Nagele's rule is calculation of expected date of delivery as 280 days from the first day of the LMP. It is valid for women having regular menstrual cycles. It cannot be used for women who do not remember LMP or have irregular menstrual cycle.

Majority of the women in our study belong to age group 26 – 30 years while majority of the patients in Naseem F et al 2013 [11] study belonged to 21 -25 years. The mean age of the women in our study ( $27.93 \pm 4.22$  years) was lower than  $29.53 \pm 3.60$  years observed by Salim R et al 2017 [12] and higher than that ( $25.77 \pm 3.95$ ) observed by Alalfy M et al 2017 [13]. Mean GA in our study was lower than that observed by Salim R et al 2017 [12] and Alalfy M et al 2017 [13]. Mean BMI of the women was lower than that observed by Alalfy M et al 2017 [13].

We compared TCD and GA in our study and observed that mean TCD in mm is equivalent to the GA in weeks from 18 to 24 weeks. Our observations were consistent with that of Bansal M et al 2014 [14]. After 24 weeks there is increase in TCD and at 36 week of gestation there is more than two fold increase in TCD. Similar results were obtained by Vinkesteyn ASM et al 2000 [15] and Agrawal C et al 2015 [16].

Descriptive of sonographic foetal biometry (median and Interquartile Range) of BPD, HC, AC, FL and TCD in our study was lower than that observed by Alalfy M et al 2017 [13] in their study.

A strong positive linear correlation was observed between TCD and gestational age (r 0.968 and p value <0.0001). Similar results were observed by various studies done previously. [9,12,15-21] The regression analysis in their study also indicated a significant relationship between TCD and GA, concluding that TCD is a useful and a precise tool for the estimation of GA.

In our study a strong positive correlation was observed between various foetal parameters (BPD, HC, AC, and FL) and GA. Our results were consistent with the observation made by Alalfy M et al 2017 in their study [13].

Gupta AD et al. (18), from India, studied TCD in singleton pregnancies and observed that the gestational age of pregnant women was not sure of their LMP can be reliably estimated by measuring the TCD which showed good correlation. The increase in TCD throughout gestation helped in assessing the development of the cerebellum.

Bansal M et al 2014 [3] and Ukey PA et al 2016 [15] observed that the TCD measurement appears to be an accurate measurement aiding in calculation of the fetal gestational age, even in the third trimester of pregnancy. It

is was recommended to use TCD as a biometric parameter in normal singleton pregnancy for the prediction of gestational age.

Malik et al. assessed the usefulness of TCD as an independent parameter for gestational age in third trimester of pregnancy in 135 patients between 26 – 38 weeks.[10] They compared the results of predicted gestational age by BPD, FL and AC with actual gestation. They observed that gestational age measured by TCD was consistently correlated with that measured by BPD, FL and AC. This correlation has also been observed in our study. In present study a linear relationship was observed between TCD and BPD, TCD and HC, TCD and AC, TCD and FL with correlation coefficients being 0.9414, 0.9493, 0.9648 and 0.9576 respectively. Our results were consistent with the study of Mathur Y et al 2018. They found a curvilinear relationship between TCD and BPD, TCD and HC, TCD and AC, TCD and FL with correlation coefficients being 0.9810, 0.9181, 0.9649 and 0.9513 respectively. [21]. Ananth et al 2007 in their study stated that TCD measurement was both reliable and accurate in determining gestational age even in extremes of fetal growth. They also observed that the TCD is extremely valuable when the gestational age is unknown or IUGR is suspected.[17]. Reddy et al. evaluated accuracy of predicting GA using foetal Transcerebellar Diameter (TCD) and compared TCD with other existing parameters in evaluating GA in 15 to 40 weeks of gestation. They showed that TCD is an accurate parameter in estimation of gestational age in second and third trimesters as its values are in close relation with that of GA by LMP. It is also better predictor of the gestational age when compared to other parameters especially in third trimester.[22]

Majority of the women in our state are uneducated who do not remember or unsure of their LMP, it becomes very

difficult to calculate their expected date of delivery. Various foetal parameters used to calculate GA in third trimester have an error of 3 – 4 weeks so in these situations TCD can be used to estimate GA more reliably. Transcerebellar diameter (TCD) is a more simple, accurate, independent, reliable and consistently superior predictor of gestational age in normal and as well as in IUGR fetuses.[2,3] TCD withstands deformation by external compression as it is surrounded by dense petrous bone and the cerebellum is the least affected parameter maintaining its size and is not affected in severe IUGR, macrosomia, abnormal skull shapes, multiple pregnancies and large for date fetuses.[1,2,3]. In our study we observed a linear relationship between TCD and gestational age indicating the reliability in the estimation of gestational age and monitoring fetal growth. Our findings are consistent with findings in previous studies.

### Conclusion

TCD is a reliable parameter for estimation of gestational age. It shows a linear correlation with gestational age. Therefore we recommend that TCD be used as an important sonographic parameter in fetuses for accurate prediction of GA especially in women who do not remember their LMP or have irregular menstrual cycle.

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**Legends Figure and Tables**

**Table 1 Demographic characteristic of the women**

Characteristics of women	Mean ± SD	Range
Age (years)	27.93 ± 4.22	19 - 42
BMI (Kg/M <sup>2</sup> )	23.97 ± 4.08	16.6 – 38.2
Gravidity	1.48 ± 0.90	1 - 6
Parity	0.45 ± 0.70	0 - 5
Gestational age (weeks)	25.07 ± 5.51	18 - 36

**Table 2: Mean TCD (mm) at different gestational age (18 to 36 weeks)**

Gestational age (weeks)	No. of cases	Lower limit –upper limit (mm)	Mean TCD (mm)
18	8	16.9 – 18.9	18.06 ± 0.59
19	12	17.4 – 20.3	19.08 ± 0.70
20	21	18.1 – 22.1	20.18 ± 1.19
21	15	18.4 – 24.4	21.03 ± 2.18
22	9	19.1 – 25.3	22.01 ± 1.93
23	12	20.3 – 25.6	23.05 ± 1.39
24	9	21.3 – 26.6	24.03 ± 1.49
25	7	21.5 – 27.3	24.24 ± 2.12
26	3	26.4 – 27.6	26.96 ± 0.60
27	5	26.5 – 30.2	27.64 ± 1.49
28	4	29.1 – 30.9	29.6 ± 0.86
29	5	29.2 – 32.2	30.66 ± 1.18
30	5	31.7 – 33.5	32.68 ± 0.65
31	6	31.8 – 36.0	33.75 ± 1.71
32	5	34.9 – 36.8	35.68 ± 0.76
33	9	35.0 – 39.0	36.5 ± 1.43
34	5	35.3 – 39.2	37.24 ± 1.64
35	5	37.3 – 40.6	38.74 ± 1.30

Table 3: Mean TCD, BPD, HC, AC and FL at different gestational age between 18 to 36 weeks.

Gestational age (weeks)	No. of cases	Mean TCD (mm)	Mean BPD (mm)	Mean HC (mm)	Mean AC (mm)	Mean FL (mm)
18	8	18.06 ± 0.59	40.66 ± 3.48	148.93 ± 9.84	121.62 ± 4.36	28.33 ± 0.75
19	12	19.08 ± 0.70	44.11 ± 4.54	163.47 ± 7.67	140.34 ± 4.41	30.15 ± 2.23
20	21	20.18 ± 1.19	47.89 ± 4.29	176.21 ± 9.18	145.96 ± 4.83	33.5 ± 2.24
21	15	21.03 ± 2.18	50.44 ± 4.12	192.72 ± 4.55	152.88 ± 3.57	33.83 ± 1.90
22	9	22.01 ± 1.93	52.66 ± 3.32	202.66 ± 6.32	154.85 ± 9.76	37.54 ± 1.00
23	12	23.05 ± 1.39	53.22 ± 2.28	205.95 ± 5.60	165.77 ± 1.83	39.96 ± 1.87
24	9	24.03 ± 1.49	56.5 ± 4.37	218.07 ± 9.62	185.22 ± 4.08	42.66 ± 1.39
25	7	24.24 ± 2.12	61.77 ± 2.26	229.7 ± 6.41	194.61 ± 5.59	44.55 ± 2.18
26	3	26.96 ± 0.60	64.53 ± 0.92	239.16 ± 3.35	203.7 ± 1.57	46.76 ± 0.45
27	5	27.64 ± 1.49	66.34 ± 1.83	244.96 ± 4.07	215.38 ± 4.59	47.82 ± 1.00
28	4	29.6 ± 0.86	70.4 ± 1.64	259.45 ± 5.44	221.45 ± 9.63	51.25 ± 0.75
29	5	30.66 ± 1.18	73.44 ± 2.95	267.16 ± 9.05	232.56 ± 5.12	54.94 ± 1.90
30	5	32.68 ± 0.65	74.36 ± 2.31	271.94 ± 6.43	243.32 ± 3.12	55.72 ± 1.48
31	6	33.75 ± 1.71	78.43 ± 2.54	280.3 ± 5.97	252.91 ± 5.75	56.65 ± 1.69
32	5	35.68 ± 0.76	80.66 ± 0.68	290.74 ± 1.98	265.72 ± 1.06	59.74 ± 1.32
33	9	36.5 ± 1.43	81.35 ± 3.70	296.85 ± 10.15	269.74 ± 6.43	62.74 ± 0.96
34	5	37.24 ± 1.64	83.5 ± 1.41	301.7 ± 5.55	273.02 ± 4.35	64.92 ± 0.66
35	5	38.74 ± 1.30	84.14 ± 2.43	302.08 ± 7.85	281.12 ± 10.37	67.1 ± 1.54
36	5	40.5 ± 1.56	86.04 ± 1.56	317 ± 10.62	302.16 ± 5.60	68.24 ± 1.50

Table 4: Sonographic foetal biometry in study population

BPD (mm)	
Range	33.7 – 88
Median (IQR)	55.75 (49.48 – 74.87)
HC (mm)	
Range	131.1 – 326.8
Median (IQR)	208.2 (182.88 – 272.8)
AC (mm)	
Range	116.5 – 310.5
Median (IQR)	167.25 (149.45 – 243.78)
FL (mm)	



Range	25.5 – 69.7
Median (IQR)	40.75 (34.2 – 55.8)
TCD (mm)	
Range	22.85 – 40.3
Median (IQR)	22.85 (20.1 – 32.43)

Table 5. Correlation between fetal biometric parameters (X) and gestational age (Y) in included women.

fetal biometric Parameters	Equation	R square	Correlation Coefficient R	P value
TCD (X)	$Y = 0.7611 * X + 5.186$	0.9532	0.9763	<0.00001
BPD (X)	$Y = 0.3605 * X + 3.232$	0.9452	0.9722	<0.00001
HC (X)	$Y = 0.1063 * X + 1.192$	0.9693	0.9845	<0.00001
AC (X)	$Y = 0.1022 * X + 5.375$	0.9844	0.9921	<0.00001
FL (X)	$Y = 0.4323 * X + 5.909$	0.9807	0.9903	<0.00001

Figure 1: linear correlation between various foetal parameters and GA

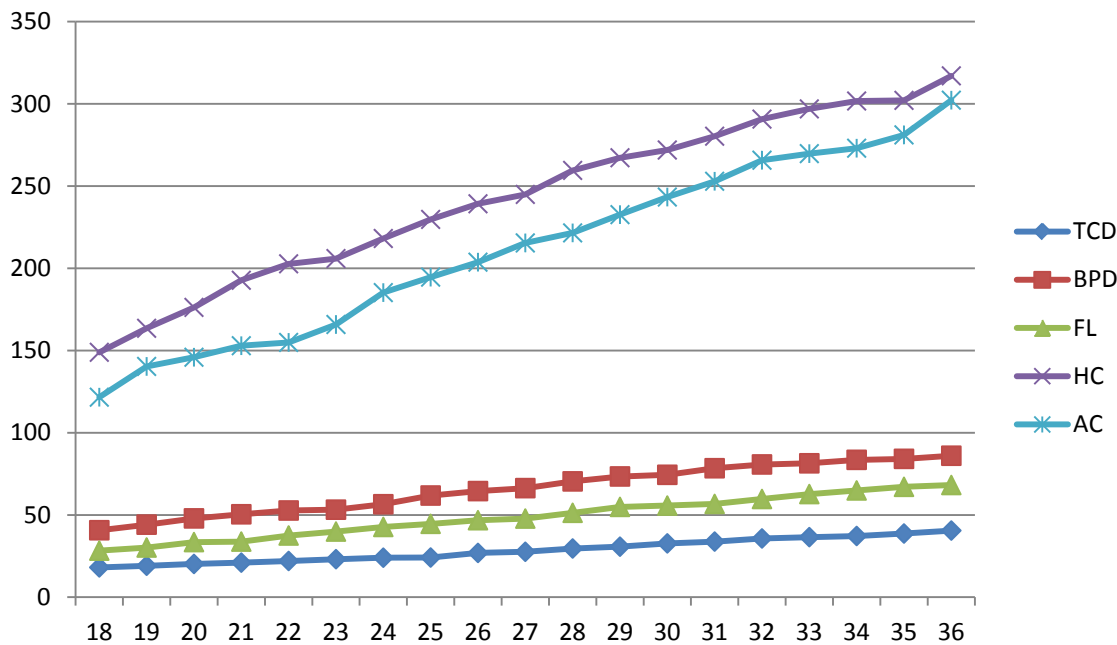


Figure 2 : Linear regression correlation between TCD and GA

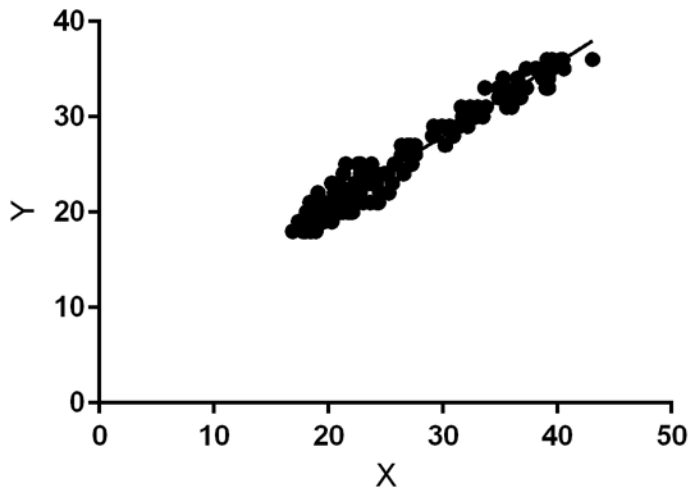


Figure 3: Linear regression correlation between TCD (X axis) and BPD (y axis)

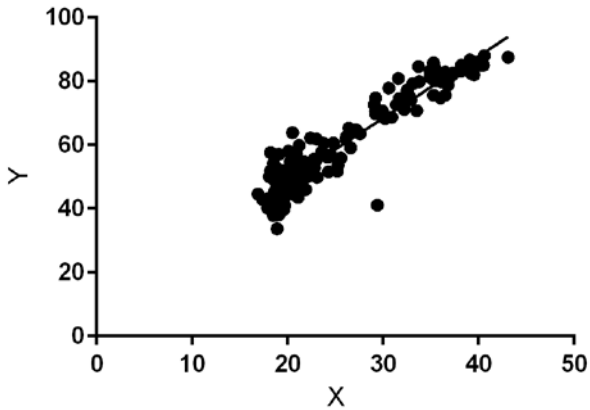


Figure 4: Linear regression correlation between TCD (X axis) and HC (y axis)

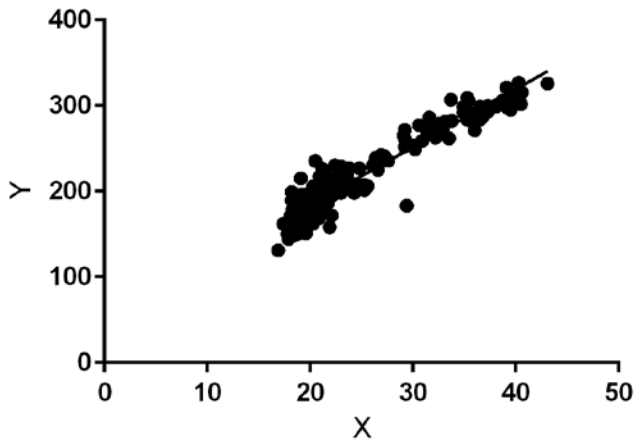


Figure 5: Linear regression correlation between TCD (X axis) and AC (y axis)

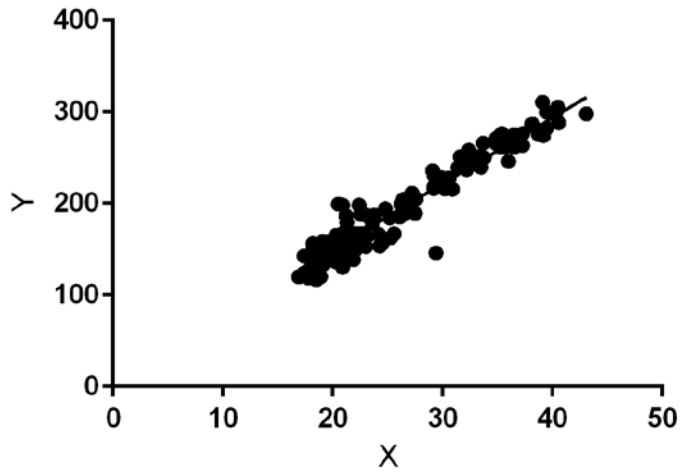


Figure 6: Linear regression correlation between TCD (X axis) and FL (y axis)

