Sonographic Estimation Of Fetal Gestational Age By Tibial Length And Its Correlation With Other Biometric Parameters.

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Abstract:

Accurate estimation of fetal gestational age is essential for optimal antenatal care. Although multiple biometric indices are routinely used. This study evaluated the usefulness of fetal tibial length (TL) in estimating gestational age using ultrasound. In a prospective analysis of 200 normal singleton pregnancies between 15–40 weeks with reliable menstrual histories, standard biometric parameters—BPD, HC, AC, FL—and TL were measured sonographically.

TL showed a clear linear increase with advancing gestation and demonstrated strong correlation with all routine parameters, especially femur length. These findings indicate that tibial length is a reliable additional marker for gestational age assessment and can enhance the accuracy of fetal biometric evaluation in routine obstetric ultrasound. Its consistent growth pattern supports its value when other parameters are difficult to obtain. Incorporating TL into routine scans may further improve antenatal dating and clinical decision-making.

I.   Introduction:

The fundamentals of perinatal care are accurate assessment of gestational age, as it plays a crucial role in guiding clinical decisions and optimizing maternal and fetal outcomes. This would prevent neonatal prematurity, significantly reduces maternal mortality and morbidity. (1) (2)

Accurate gestational age (GA) estimation by ultrasonography is essential for monitoring fetal growth, planning timely interventions, and managing complications that may arise during pregnancy they are also important for the interpretation of biochemical screening tests and also it helps in patient counselling regarding options for early termination of pregnancy. Routinely used standardized parameters like Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL) are preferred because they exhibit minimal biological variation and can be measured with a high degree of consistency across different observers.(3) (4)

Morphometry of long bones of limbs by ultrasonography shows high degree of correlation with the gestational age, data obtained for these being highlighted in various studies.(3) Among the long bones of the extremities Femur length (FL) is being assessed and measured extensively, which shows good correlation with gestational age in second and third trimester of pregnancy. Literature also suggests that femur showed some mild physiological bowing after 18 weeks of gestation that can lead on to some errors in estimation of gestational age. (5) (6) Hence it is established that a combination of parameters is the suitable method to increase the accuracy of gestational age estimation.

Tibia being a long bone of the extremity can be easily assessed by ultrasonography and its length increases proportionately with the fetal growth along with other bones. Tibial length (TL) is not used as a routine parameter in assessing the gestational age. (7) Very few studies are being done by Indian authors regarding Tibial length measurement and its correlation with GA. There are few studies where they have used tibial length measurement in detecting skeletal long bone anomalies and dwarfs. (8)

We conducted this study in our institute to establish the relationship between tibial length and gestational age of fetus. We also compared the gestational age estimation by tibial length with other standard parameters like BPD, HC, AC and FL, to determine whether it can be an alternative parameter to existing biometric parameters.

Figure 1: Ultrasonographic image of tibial length

II. Objectives:

1. To measure fetal tibial length sonographically.
2. To calculate fetal gestational age by measuring fetal tibial length sonographically.
3. To compare fetal tibial length with other standard fetal gestational age parameters.

III. Methodology:

After Ethical committee approval, a duly sought written and informed consent of the participants, a detailed history will be taken regarding personal, menstrual and obstetric background according to proforma. A complete form –F in compliance to Pre-Conception and Pre-Natal Diagnostic Techniques Act (PCPNDT) is filled according to guidelines of Govt of India.

Inclusion criteria:
All subjects with normal singleton pregnancy between 15-40 weeks.
All subjects with accurate LMP and menstrual history.

Exclusion criteria:
Subjects who have multiple gestation.
Subjects with inaccurate LMP.
Subjects with medical conditions.
Early gestational period (<15 weeks).
Subjects with oligohydramnios.
Fetus with congenital anomaly and growth retardation.

Imaging protocol: All examinations were performed using a gray scale real time ultrasonography machine GE Voluson P8 Ultrasound system using 3- 6 MHz curvilinear transducer, few scans were also done on Mindray resona i9 Ultrasound system.
Standard parameters like BPD, HC, AC and FL were measured using routinely used techniques.
Tibial length: Measuring the tibia is done after the femur has been measured. Caudally slide the probe from the FL region till the two bones of leg are visible. A cross-section of tibia and fibula are usually seen at this point as echogenic linear structures, parallel to each other.

For measuring the tibia, near end of probe is chosen. Because of acoustic shadowing from fetal tissues prior to it, the tibia at the far end of the probe is typically difficult to scan properly. Rotate the probe slowly while keeping the echo from the front tibia in view until the complete length of the tibia is captured. In freeze frame longitudinal and parallel measurement of tibial bone is taken in relation to fibula. Tibial length is taken between two blunt ends or between medially cast acoustic shadows excluding epiphysis at the near end of probe. (9) (10).

Gestational age of the fetus is calculated using formula by Jeanty et al. (8) The measurements of all the above parameters are measured in millimetres.

IV.   Results:

A total of 200 normal singleton pregnant women between 15-40 weeks of gestation were submitted for sonographic examination.

Table 01: Maternal age distribution:

Age in years	Number of cases	Percentage
<20 years	10	5.0
20-25	77	38.5
26-30	86	43.0
>30 years	27	13.5
Total	**200**	**100.0**

Table 02: Distribution of cases according to GA:

GA (Weeks)	Number of Cases	Percentage
15.0	3	1.5
16.0	6	3.0
17.0	3	1.5
18.0	3	1.5
19.0	5	2.5
20.0	14	7.0
21.0	5	2.5
22.0	5	2.5
23.0	3	1.5
24.0	4	2.0
25.0	3	1.5
26.0	7	3.5
27.0	10	5.0
28.0	15	7.5
29.0	17	8.5
30.0	5	2.5
31.0	13	6.5
32.0	14	7.0
33.0	7	3.5
34.0	10	5.0
35.0	15	7.5
36.0	14	7.0
37.0	7	3.5
38.0	6	3.0
39.0	4	2.0
40.0	2	1.0
Total	**200**	**100**

Table 03: Correlation between mean & SD values TL, BPD, HC, AC and FL with GA.

GA (Weeks)	TL(mm) Mean ± SD	BPD(mm) Mean ± SD	HC(mm) Mean ± SD	AC (mm) Mean ± SD	FL(mm) Mean ± SD
15.0	15.13 ± 0.06	28.97 ± 0.12	113.07 ± 0.12	93.73 ± 0.40	17.73 ± 0.40
16.0	18.63 ± 0.45	33.93 ± 2.12	125.10 ± 0.22	115.15 ± 10.90	22.20 ± 0.66
17.0	20.80 ± 0.00	37.50 ± 0.00	143.50 ± 0.00	115.50 ± 0.00	25.00 ± 0.00
18.0	22.73 ± 0.23	40.07 ± 0.81	155.40 ± 3.98	124.13 ± 5.08	26.60 ± 0.52
19.0	26.60 ± 0.89	44.20 ± 1.79	168.12 ± 3.86	142.66 ± 4.87	30.30 ± 0.76
20.0	28.47 ± 1.55	47.18 ± 1.54	178.43 ± 5.64	152.56 ± 5.32	33.01 ± 1.36
21.0	31.00 ± 1.17	51.52 ± 1.49	193.76 ± 3.79	171.24 ± 6.34	35.00 ± 0.94
22.0	33.64 ± 0.78	51.10 ± 2.38	198.72 ± 5.08	177.34 ± 3.96	37.36 ± 1.10
23.0	35.30 ± 0.00	56.40 ± 0.00	211.00 ± 0.00	184.40 ± 0.00	42.20 ± 0.00
24.0	38.28 ± 1.28	60.85 ± 2.17	224.15 ± 4.22	202.08 ± 4.13	44.15 ± 0.10
25.0	40.30 ± 0.00	62.90 ± 0.00	234.70 ± 0.00	210.70 ± 0.00	48.40 ± 0.00
26.0	43.51 ± 0.46	66.49 ± 1.96	246.89 ± 7.67	217.29 ± 6.52	48.80 ± 1.22
27.0	45.73 ± 1.71	70.52 ± 4.00	253.90 ± 5.18	227.07 ± 6.59	51.95 ± 1.60
28.0	47.27 ± 1.25	71.60 ± 1.94	262.97 ± 12.94	240.85 ± 9.68	55.78 ± 3.93
29.0	49.84 ± 1.48	74.48 ± 2.99	275.71 ± 5.37	248.98 ± 6.71	57.10 ± 1.33
30.0	50.58 ± 3.10	77.02 ± 3.24	284.98 ± 2.41	263.52 ± 9.23	60.04 ± 1.35
31.0	52.21 ± 1.36	79.38 ± 1.84	289.64 ± 3.55	266.78 ± 12.73	60.76 ± 1.74
32.0	55.94 ± 2.20	80.54 ± 2.36	298.31 ± 9.14	280.45 ± 6.93	63.28 ± 1.93
33.0	56.91 ± 0.71	84.14 ± 1.22	312.30 ± 5.85	290.73 ± 3.37	65.13 ± 1.36
34.0	58.56 ± 1.49	85.49 ± 1.59	312.23 ± 3.83	304.82 ± 6.75	66.37 ± 1.45

35.0	61.51 ± 2.66	87.41 ± 1.71	319.19 ± 6.60	313.47 ± 6.01	69.16 ± 2.41
36.0	63.44 ± 2.39	89.42 ± 1.85	323.09 ± 8.47	320.22 ± 9.91	70.86 ± 1.32
37.0	62.77 ± 1.95	86.46 ± 9.06	313.60 ± 28.57	308.46 ± 43.01	70.11 ± 5.45
38.0	65.50 ± 1.69	93.30 ± 1.29	338.23 ± 10.48	333.87 ± 7.00	73.17 ± 1.93
39.0	68.20 ± 0.00	95.60 ± 0.00	339.20 ± 0.00	355.50 ± 0.00	76.30 ± 0.00
40.0	71.40 ± 0.00	99.60 ± 0.00	348.90 ± 0.00	372.30 ± 0.00	80.20 ± 0.00

Figure 16: Ultrasonographic image of tibial length at 28 and 20 weeks.

V.   Discussion:

Ultrasonographic estimation of fetal gestational age is one of the important aspects of obstetric practice in recent days. Key findings and implications of our study are as follows:

Age group: The participants in this study were in the age group of 18 and 36 years. Majority of the women in the study were between 26-30 years (n=86, 43%). The women in the age group of 20-25 years were 77 cases accounting to 38.5% comprising of second highest group. The age < 20 years group comprising of fewer cases (n= 10, 5%)(Table -01).

Frequency of cases and number of measurements for each week of gestational age: Out of 200 cases of gestation between 15-40 weeks, there were enough representation for all gestational age. The highest number of measurements (n=17) were seen at 29 weeks of gestation and lowest number of measurements (n =2) were seen at 40 weeks of gestation. More than 10 cases were obtained for gestational age of 20, 27, 28, 29, 32, 34, 35 and 36 weeks (Table -02).

Correlation between gestational age and mean & SD values of TL, BPD, HC, AC & FL: Compilation of mean and SD values of all the 5 parameters and correlation with the gestational age was done (Table – 03). TL had linear correlation with all the parameters like BPD, HC, AC and FL (Graph- 01). The correlation was very significant with FL as depicted by statistical correlation tests.

The parameters like BPD, HC, AC and FL have been studied in multiple studies and are having separate nomograms which have a significant correlation. Our study on tibia has few studies to compare with and we have successfully established correlation with above mentioned parameters with significant statistical correlation (11-15).

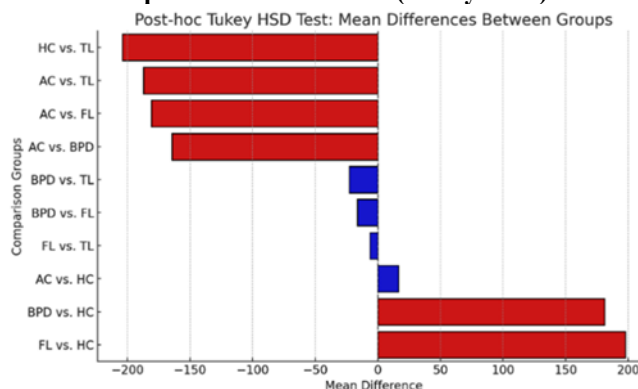**Graph 01: Correlation between gestational age and mean & SD values of TL, BPD, HC, AC and FL:**
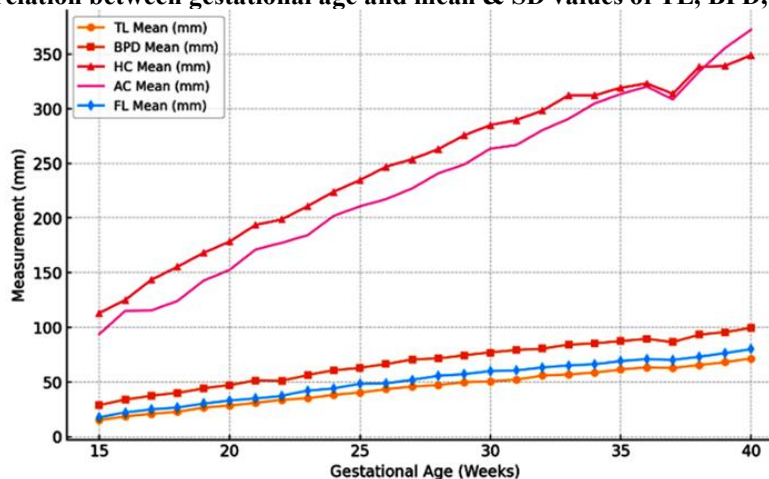
Table 04: Statistical correlation tests and values:

GA (Weeks)	Pearsons correlation	P value	Total No
BPD	0.992(**)	0.001	200
HC	0.988(**)	0.001	200
AC	0.994(**)	0.001	200
FL	0.996(**)	0.001	200
TL	0.997(**)	0.001	200

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

Graph 02: Post Hoc Tests (Tukey HSD).

Red bars indicate statistically significant differences.
Blue bars represent non-significant differences.
The dashed line at zero helps visualize the direction of the differences.

VI.   Conclusion

Ultrasound remains an invaluable, non-invasive, non-ionizing, cost effective, readily available investigative tool for evaluation of fetal gestational age and to provide better obstetric care. Fetal tibia being a long bone, the growth pattern with the increasing gestational age is linear and direct. It can be used as a reliable indicator of fetal GA.

Fetal tibial sonographic identification and measurement is easy, convenient and can be used to estimate fetal gestational age through the gestation between 15-40 weeks. There is a strong correlation of tibial length and other conventional parameters namely BPD, HC, AC and FL and hence it can be used as an alternate parameter for estimation of fetal GA.

As tibia has lesser maldevelopment for congenital anomalies. Fetal TL measurement can be used to rule out possible long bone anomalies. Hence all the findings of this study conclude that the fetal tibial length can be used as a good biometric marker for estimation of fetal GA.

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