

ULTRASONOGRAPHIC ESTIMATION OF FETAL GESTATIONAL AGE BY FETAL KIDNEY LENGTH, IN TERTIARY CARE CENTRE GWALIOR

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Abstract:

In this study we evaluated ultrasonographically the kidney length for the assessment of gestational age and foetal growth and to compare this parameter with other routinely used parameters such as the BPD, FL. This cross-sectional study was done with 100 pregnant women with low risk pregnancy, ranging from 18-40 weeks of gestation at the Department of Radiodiagnosis and Department of Anatomy, G.R. Medical College, Gwalior (M.P.). The period of gestation was calculated by LMP and clinical examination. Further, for all these patients several geometric parameters i.e. biparietal diameter, femur length and kidney length were obtained and compared. The coefficient of correlation: BPD ($R^2=0.988$, p value < 0.01) and SL ($R^2=0.962$, p value < 0.001) were observed in the present study. They showed high degree of linear progressive relationship with gestational age. In situations where head shape is altered significantly, such as in breech presentation or transverse like, FL measurement offers better correlation than BPD. Femur length is very reliable and consistent marker of gestational age even when BPD cannot be relied upon, as in late third trimester, after the head is engaged and in cases of hydrocephalus, ancephaly and dolichocephaly. A statistically significant positive correlation was found between the kidney length and gestational age ($R^2=0.962$) indicating it to be a reliable indicator of gestational age especially towards the third trimester. As kidney length is independent of foetal head, it can be a useful alternative parameter in conditions where the foetal head is not accessible as in third trimester deeply engaged head or when head is deformed due to overcrowding such as in multiple pregnancy. It is useful in conditions of femur length deformities along with skull deformity like achondroplasia etc.

Key Words: Ultrasonography, Fetal kidney length, In tertiary care centre, Gwalior

Introduction

Initially the dating of pregnancy was based on first day of last menstrual period (LMP) in a regular 28 days menstrual cycle. But this method for dating the pregnancy is failing in those women who do not exactly recall their menstrual history. Ultrasound, is more reliable methods to date the pregnancy. In the first trimester, these are mean gestational sac diameter

& volume, and crown rump length (CRL) measurement. In the second trimester, the most commonly used biometric indices for dating pregnancies are biparietal diameter (BPD), femur length (FL)¹, abdominal circumference (AC) and other used parameter are transverse cerebellar diameter², scapular measurement³, fetal kidney length⁴ and fetal renal volume⁵. Fetal kidney is easy to identify and measure in the late second and in the third trimesters

and there is strong correlation between gestational age and fetal kidney length. Sonographic measurement of the fetus provide information about fetal age and growth. They are used to assign gestational age, EDD, estimated fetal weight, and diagnose growth disturbances. Fetal biometry is a method devoted to the measurement of several parts of fetal anatomy and their growth. Standard fetal growth charts and tables as given by the previous workers of obstetric ultrasound evaluate whether the dimensions of a particular parameter are normal for the age. In recent years ultrasonography has appeared major diagnostic tool for foetal anomalies. As reported, it has been suggested that all patients should be offered relative ultrasound screening as 90% of infants with congenital anomalies are born to women with no risk factors.^{6,7}

Prenatal ultrasonography is expected to reduce the rate of perinatal mortality through pregnancy termination for prenatally diagnosed congenital malformations. It provides more accurate estimation of age which prevents unnecessary labour inductions.^{8,9,10}

Accurate dating is essential for the proper timing of Chorionic Villi sampling and Nuchal Translucency assessment, amniocentesis and timing for elective caesarean section.¹¹

Gestational age is determined by measuring the foetal parameters of interest from the acquired ultrasound image. Compared with the physical examination of the pregnant uterus and menstrual history, the most accurate method for assessing and tracking foetal size and growth is the use of ultrasound imaging and measuring of the various foetal parameters.^{12,13,14}

The measurements obtained from various features of the foetus were then compared with foetal measurement charts which relate the observed value of a foetal parameter to gestational age or growth.

The present study was undertaken to correlate ultrasonographic sacral length measurement, with gestational age and to compare it with gestational age determined by other parameters that are routinely used for the ante partum foetal age determination (BPD, HC, AC, FL).

In the present study we tried to measure fetal kidney length (FKL) for estimation of age of foetus and compare it with

other biometric indices.

Aims And Objectives

1. Ultrasonographic estimation of fetal gestational age using fetal kidney length as a parameter.
2. To compare estimation of fetal gestational age, using parameter fetal kidney length and fetal biparital diameter.
3. To compare estimation of fetal gestational age, using fetal kidney length and fetal femur length.

Material And Methods

STUDY CENTER: Department of Anatomy Gajra Raja Medical College Gwalior (M.P.) and Department of Radiodiagnosis ,Gajra Raja Medical College Gwalior (M.P.)

DURATION OF STUDY: One year Dec 2016 to Nov 2017

STUDY DESIGN: Randomized, prospective and observational study.

In Present study obstetric ultrasonography of 100 women with age group of 18 to 35 years were analyzed. Obstetric Ultrasonography required for this study was obtained from Department of Radio diagnosis, G R Medical College Gwalior. Letter of consent from HOD Department of Radio diagnosis, G R Medical College Gwalior, was received.

Inclusion Criteria

Pregnant women with age group between 18 to 35 years, having single live normal fetus and women with gestational age >17 weeks by date.

Exclusion Criteria

1. Pregnant women younger than 18 years or older than 35 years.
2. Women with gestational age <17 weeks by date.
3. Pregnant women with multiple pregnancies.
4. Pregnant women suffering from eclampsia and pre-

eclampsia.

5. Pregnant women with chronic hypertension.
6. Pregnant women with diabetes mellitus.
7. Pregnant women with intrauterine growth retardation and with previous history of IUGR.
8. Pregnant women with any associated congenital anomaly.
9. Pregnant women with associated medical diseases.

Methods

The case was tested as per the following protocol

1. Initial history taking
2. Clinical examination
3. Laboratory investigation
4. Ultrasonographic examination

1. History taking: Details of history regarding regularity and the duration of menstrual period were taken. Date of LMP, the period of gestation by date at the time of examination and expected delivery date was calculated by *Naegele's* formula.

2. Clinical examination: Cases were examined for anaemia, icterus, cyanosis, oedema, pulse and blood pressure. Systemic examination for any cardiovascular or respiratory disease, obstetric examination to estimate the Fundal height, foetal lie, multiple pregnancy, obvious IUGR or poly-oligohydramnios was carried out.

3. Laboratory investigation: To rule out maternal disease, likely to affect the outcome of pregnancy; routine blood examination was carried out. This included haemoglobin, blood group, urine for albumin and sugar, blood urea and blood sugar.

4. Ultrasonographic examination: (A) Preparation of the patient- A full bladder serves as an acoustic window for better visualization of the uterus, its contents and the adnexa. It pushes other pelvic contents like bowel loops away from uterus and aids to straighten the anteverted uterus. Therefore, the patients were instructed not to empty the bladder 3 hrs prior to the examination especially in early pregnancy. If needed they were advised to take plenty of oral fluids in order to fill their urinary bladder.

(B) Technique of scanning: The examination was performed

using a gray scale real time scanner, ALOKAPROSOUND Alpha-C Ultrasonographic Machine with Convex Probe 2.5-6 MHz curved array transducer. At a single sitting biparietal diameter, head circumference, femur length and kidney length were measured. The measurements were taken employing freeze frame technique using electronic callipers calibrated in mm. First a routine general survey was performed to determine the foetal lie, presentation, foetal viability and to exclude multiple gestation. The biparietal diameter is measured using the technique described by **Campbell, 1986**. As per his technique a longitudinal scan is made to determine the angle of foetal head to vertical axis (the angle of asynclitism). A true transverse view of foetal skull, which shows an ovoid image with a discontinuous midline echo, was obtained and frozen. The BPD was measured in the scan which shows the widest diameter at the line of midline echo complex (the inter-hemispheric fissure); cavumsepti pellucid and thalami, three measurements were made with electronic callipers and the maximum diameter was recorded. The reference point for BPD is the measurement from inner margin of proximal skull interface. The BPD thus obtained was compared with standard nomogram suggested by **Sabbagha et al 1978** and its accuracy determined. For measuring femur length the transducer was placed at right angles to the foetal spine and passed down the foetus maintaining this angle to the caudal end. Since the distal femur is usually flexed, the transducer was rotated from this position through 30-45 degree towards abdomen until full length of femur was visualized. To ensure that one has the longest femur length, measurements should be taken along an axis that shows both the round echogenic cartilaginous femoral head and femoral condyle, measure from proximal to distal femoral metaphysis with the help of electronic callipers (**O'Brien et al 1980**). The kidney length thus obtained was then compared with the standard nomogram provided by David M Sherer et al 1993 and its accuracy determined. The maximum renal length is measure from upper pole to lower pole in a longitudinal section of fetus in parasagittal plane. We will measure both kidneys of fetus. The fetal kidneys appear ultrasonographically as a echogenic tissue surrounding the hypoechoic pelvicalyceal system. The kidneys are difficult to identify prior to 17 weeks of gestation. The standard methods of obtaining BPD and FL will be employed. After confirming the lie, axial sections are obtaining perpendicular to the spine, adjusting the position of patient, tilting the scanning arm for the best result.

Data Collection and Statistical Analysis-After taking note of the routine parameters i.e. BPD, FL and kidney length, the complete information was recorded in the Proforma. Each parameter so recorded, was compared with its standard nomogram. Suitable bar diagram, scatter diagram and pie charts were made to represent the data. Mean and Correlation tests were applied for analysis and interpretation of the results. SPSS software used for statistical analysis.

Observation And Results

The study was conducted in Department of Anatomy and Department of Radiodiagnosis, G.R. Medical College, Gwalior (M.P.), on 100 women with singleton uncomplicated pregnancies without known structural or chromosomal foetal anomalies. Pregnancies with maternal complication of pregnancy or abnormal foetal growth were excluded.

A total of 100 subjects were studied. Gestational age was determined with a well defined last menstrual period and clinical examination. Gestational age ranged from 18 to 40 weeks. Various parameters BPD, HC, and kidney length were meticulously recorded. Each parameter is then compared with its standard western nomogram and the accurate parameters are noted for that known gestational age.

Clinical characteristics

Table 1
Age of patients

Age Group	No. of Cases	Percentage
19-21 yrs	31	31
21-27 yrs	51	51
> 27 yrs	18	18

The patients were between 18-35 yrs of age. The maximum numbers of patients were patients were from the 21-27 yrs of age group

Table 2
Gravidity of patients

Gravidity	No. of Cases	Percentage
Primigravidae	27	27
Multigravidae	73	73

The maximum of the patients included in the present study were Multigravidae.

Table 3
Distribution of cases according to known menstrual age

Known menstrual age (in weeks)	No. of cases	Percentage
15-20	6	6
20-25	16	16
25-30	26	26
30-35	40	40
35-40	12	12
Total	100	100

From the above data we can see that the maximum no. of cases were between 30-35 weeks of gestation

Ultrasonographic Assessment Of Foetal Maturity By Conventional Parameters

Foetal maturity was assessed by the conventional parameters namely:

1. BPD
2. Femur length

The credibility of the above parameters has been proved by various previous standard nomograms given by previous researchers.

BI - PARIETAL DIAMETER

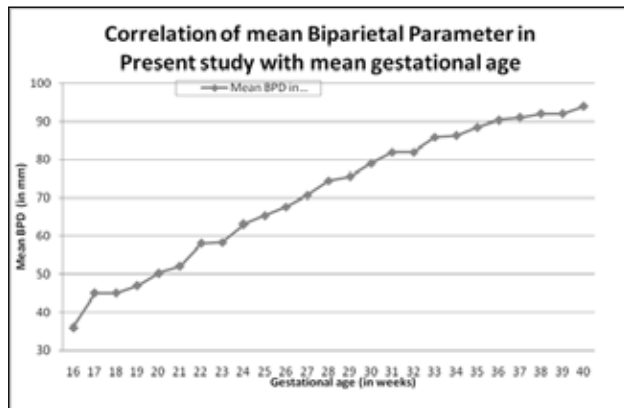
BPD - in the present study was compared with standard nomogram by Sabbagha and Hughey 1978 (Table 4).

Table: 4
Comparison of mean BPD in present study with standard BPD nomogram

Gestational age (in weeks)	Standard Nomogram (Sabbagha & Hughey) (mm)	Mean BPD in Present study (in mm)
16	36	36
17	39	45
18	42	45
19	45	47
20	48	50.25
21	51	52
22	54	58
23	58	58.25
24	61	63
25	64	65.25

26	67	67.66
27	70	70.66
28	72	74.5
29	75	75.6
30	78	79
31	80	82
32	82	82
33	85	85.9
34	87	86.25
35	88	88.5
36	90	90.4
37	92	91
38	93	92
39	94	92
40	95	94

Except in conditions of abnormal head position head shape such as breech presentations or dolichocephaly, BPD was found to be a good indicator of gestational age between 18-30 weeks. In the later period of gestation (30-40 weeks) the accuracy of predicting gestational age by BPD decreased with a difference of 2-3 mm. The maximum error in predicting gestational age was 1 week with a mean error of 0.31 weeks.



Scatter graph was plotted between BPD and gestational age and their correlation was calculated. Overall Pearson's coefficient (r^2) between the two was found to be equal to 0.988 ($P < 0.01$).

FEMUR LENGTH (FL)-Femur length is used as a reliable parameter for gestational age determination. It is especially of value in conditions where head cannot be used accurately like dolichocephaly, brachycephaly, deeply engaged head and also in IUGR where it is last to be effected. The femur-length in the present study correlated well with the standard nomogram by Hadlock et al 1983 (Table 7). Beyond 32 weeks, the femur length was more close to the standard value. The maximum error in predicting menstrual age was found to be 1.5 week and mean error 0.25 week. A highly

significant coefficient of correlation ($R^2=0.996$) between femur length and gestational age was observed indicating it to be a reliable predictor. Scattered graph was plotted between gestational age and femur length and coefficient was calculated.

Table: 5
Comparison of mean femur length in the present study with the standard nomogram by Hadlock et al 1982

Gestational age (in weeks)	Standard Nomogram (Hadlock et al 1982) (mm)	Mean Femur length in present study (mm)
16	23	23
17	26	27
18	28	30
19	30	33
20	33	36
21	35	37
22	38	40.5
23	40	42.25
24	42	45.33
25	45	47
26	47	48.66
27	49	51.8
28	52	54.25
29	54	55.8
30	57	58.125
31	59	60.5
32	61	62.14
33	64	64.8
34	66	67.125
35	69	68.25
36	71	71.6
37	73	73
38	76	76
39	78	80
40	80	79

Scattered graph was plotted between gestational age and femur length and coefficient was calculated.

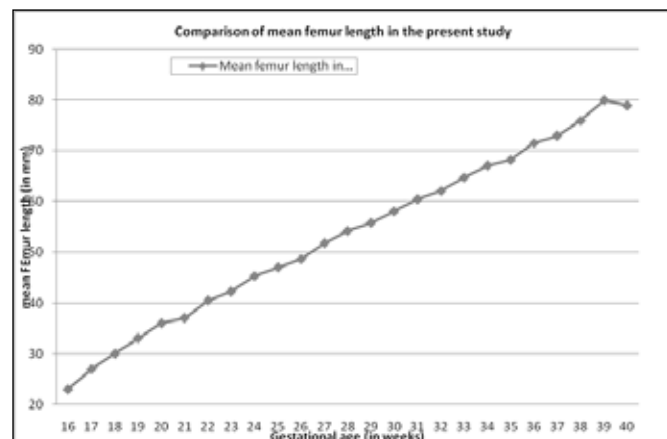
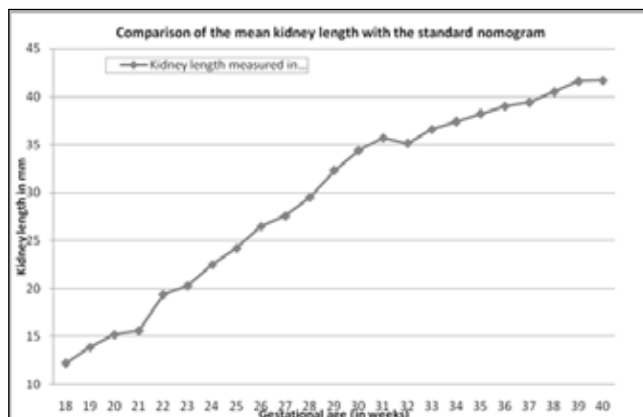


Table 6
Comparison of the mean kidney length with the standard nomogram

Gestational age (in weeks)	Standard momogram JJ Kansaria et al (2009) (in mm)	Kidney length measured in present study (in mm)
18		12.2
19		13.9
20		15.2
21		15.6
22		19.4
23		20.3
24	23.87	22.5
25		24.2
26	25.23	26.5
27		27.6
28	26.98	29.5
29		32.3
30	29.03	34.4
31		35.7
32	30.80	35.1
33		36.6
34	32.51	37.4
35		38.2
36	34.26	39.0
37		39.4
38	36.25	40.5
39		41.6
40		41.7

The observation showed that present study data correlates very well with the standard monogram thorough gestation. A scattered graph was plotted between kidney length measurement and gestational age their correlation was calculated.



A statistical significant liner correlation was found between the kidney length and gestational age ($R^2=0.962$) indicating reliable indicator of gestational age. The sonographic evaluation of kidney length shows a linear relationship throughout the gestation. The kidney is present (in mm)

is within mean of the study by JJKansaria et al. The kidney length in millimeter corresponds exactly with the gestational age in weeks more in the third trimester.

Table: 7
Distribution of kidney length measurement (in mm)

Kidney length (in mm)	Gestational age (in weeks)	No. of cases	% of cases
15.26	18-22	15	15
26.13	23-29	33	33
38.13	30-40	52	52
Total		100	100

Majority of the cases 52% of the kidney length values are between 38.13 mm corresponding to period of gestation ranging from 30-40 weeks.

Table: 8
Statistical analysis of the kidney length measurements

Independent variable	Dependent variable	Coefficient of correlation
Kidney length	BPD	0.988
Kidney length	FL	0.997
Kidney length	Gestational age	0.962

The Pearson Coefficient (R^2) obtained from regression analysis of kidney length with BPD and femur length demonstrate the relative strength of kidney length measurement as compared with standard parameters of gestational age and foetal growth.

Discussion

Ultrasonography is a useful means of detecting gestational age and to monitor foetal growth and development accurately. Gestational age must be reliably established so that needless interference and perinatal morbidity and mortality rates can be decreased.

The present study, has been undertaken to establish the foetal kidney length as a new and unique parameter, which is independent and can also be used when other parameters cannot be relied upon due to some reasons. A total of 100 singleton pregnant women between 18-40 weeks of gestation were included in the study. These women had uncomplicated pregnancies and without known structural or chromosomal foetal anomalies. Pregnancies with oligohydramnios or polyhydramnios, maternal diabetes or hypertension were excluded from the study.

The gestational age was determined from well defined last menstrual period, abdominal and pelvic examination. The ultrasonographically observable conventional parameters currently available are biparietal diameter (BPD), femur length (FL).

Biparietal Diameter

Biparietal diameter is a reliable method of estimating the gestational age (Sabbagha et al 1976)¹⁵. The relationship between the BPD and the gestational age has been studied by various workers (Campbell 1969¹⁶, Sabbagha 1974¹⁷, Buckshee et al 1983¹⁸ and Kurtz et al 1980¹⁹).

In the present study the correlation coefficient between gestational age and BPD is equal to 0.988, indicating a high level of correlation between the two. In spite of the high level of correlation, the varying of growth patterns in different individuals makes prediction by BPD inaccurate in the third trimester. Breech presentation, dolichocephaly, uterine anomalies and multiple gestations further reduce the reliability of this parameter. BPD is difficult to record after the head gets engaged in third trimester.

Femur Length

Femur length has a linear relationship with gestational age, similar to BPD, but the growth appears to be slow in third trimester. Foetal femur length has been used widely for the prediction of menstrual age. (O'Brien et al (1980)²⁰, Hohler et al (1981)²¹, O'Brien et al (1981)²², Hadlock et al (1982)²³). Femur length is also very reliable and consistent predictor of gestational age when BPD cannot be relied upon as in late third trimester, after the head is engaged, and in cases of hydrocephalus, anencephaly and dolichocephaly. In the present study, the correlation coefficient of femur length and gestational age was found to be 0.997 and p value was <.001. In the present study, femur length was seen as a better indicator of gestational age than BPD. It is an established fact that the Indian foetal growth due to the influence of various socioeconomic and environmental factors is less than western standards. But the outcome of foetuses was found to be normal with lower birth weights in comparison with western Hadlock's charts. Hence, they cannot be labelled as cases of IUGR, in the Indian setup (Meire HB et al 1981)²⁴

Kidney Length Measurement

The foetal kidney is consistently identifiable structure and a landmark that provides a reproducible plane for measurement. The foetal kidney is most easily visualised with in foetuses after 18 weeks. The kidney is lobulated in intrauterine and it becomes single after birth. Its ultrasonographic appearance as sonolucent halo of tissues surrounding the somewhat more echogenic pyelocalyceal sinus. Hence, fetal kidney length appears as an early achieved and valuable parameter which directly and strongly correlates with gestational age and other biometric measurements. Therefore, fetal kidney length can be utilized as a complementary tool in both the evaluation fetal growth and prediction of gestational age. Further research is required to determine the significant of fetal kidney length in prenatal followup.

Conclusion

Fetal kidney length can be used as an investigational tool in the determination of gestational age in the late second and third trimester of pregnancy. Fetal kidney length is not affected by the discrepancy of late trimester or by fetal growth retardation. The best linear regression model for estimating fetal gestational age is FL, LK and BPD. In rural Indian women, the illiteracy rate is higher than in urban women. Thus, mainly rural pregnant women do not given their proper menstrual history. Thus, in these cases fetal kidney length can be used as a tool for estimating fetal gestational age in the second and third trimesters and it can be applicable in routine practice in general population. This study has provided normative kidney length measurements thoroughly pregnancy—especially towards the third trimester. Kidney length can be used as a reliable routine parameter and also as an alternative: in conditions where other routine parameters are difficult to assess or give incorrect predictions.

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