Calculation of gestational age based on fetal kidney length: a study in central India region

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Abstract: *Ever since the advent of Fetal biometry in Obstetric Ultrasonography for the calculation of Gestational age of the fetus, embryologists, obstetricians and sonologists all over the world have been constantly searching for a single most accurate index to be able to calculate the gestational age correctly. Many indices were suggested to calculate GA. Various studies by experts all over the world have been adding new inputs regarding the authenticity of these parameters. Parameters like BPD, FL, MC and AC are used currently to determine the GA of the fetus. But these parameters might be inaccurate in late pregnancy. Furthermore there is a substantial evidence that the standard deviation for these indices widen as pregnancy progresses.*

In a hunt to discover a method which could accurately predict gestational age even in advanced stages of gestation, various non- traditional sonographic parameters are being studied. These include transverse cerebellar diameter, fetal foot length, epiphyseal ossification centers, amniotic fluid volume and placental thickness.

Fetal kidney length is one such non-traditional parameter for estimating gestational age under study. Fetal kidneys are easy to identify and measure. The length of kidneys during fetal life is strongly correlated to gestational age and its linear growth during gestation has been demonstrated on MRI also.[61] It is a more accurate method of GA estimation than BPD, FL, HC and AC after the 24th week of gestation. The observations of the present study showed that the mean kidney lengths increased linearly with each week of gestation.

Keywords: *Pregnancy, ultrasound, fetal kidney length, gestational age.*

I. Introduction

The journey of a newborn from its conception to its birth is a miracle of nature. From the stage of a two celled zygote, it undergoes cell division, specialization, differentiation, morphogenesis, etc. and develops with organs such as brain, spinal cord, heart, lungs, genitourinary system, and so on. The accurate knowledge of Gestational age is a keystone in an obstetrician's ability to successfully manage the antepartum care of a patient and is of critical importance in antenatal care of a patient and planning antepartum intervention. In high risk pregnancies like Pre-eclampsia, IUGR, gestational diabetes, chronic renal disease, central placenta previa, Rh-ve mothers, the importance of accurate gestational age calculation is important for proper management and decision making regarding intervention. Accurate GA estimation is also necessary, where certain tests need to be performed like amniotic fluid and serum assays, chorionic villous sampling and to plan fetal therapies.

II. Basics Of Ultrasonography And Use Of Ultrasound In Fetus Biometrics:-

Sound and ultrasound waves consist of a mechanical disturbance of a medium such as air. The disturbance passes through the medium at a fixed speed causing vibration. The rate at which the particles vibrate is the frequency, measured in cycles per second or hertz (Hz). Sound becomes inaudible to the human ear above about 20 KHz and is then known as ultrasound. Most medical diagnostic application of ultrasound employs frequencies from 2-20 MHz.[1]

Diagnostic imaging uses much higher frequencies, in the order of megahertz. The higher the frequency used, the better the resolution (the ability to distinguish two adjacent objects). However, as the frequency increases, more of the ultrasound beam is absorbed by the medium and the beam cannot penetrate so far. For this reason, higher frequencies (7.5MHz) are used to provide good detail of superficial organs such as the thyroid gland, testes & breast, and lower frequencies (3.5MHz) for examination of the abdomen.

Fetal Biometry:

Biparietal Diameter (BPD):- It is the maximum distance between two parietal bones at the level of cavum septum pellucidum. This parameter is used in the second trimester, from 12th week onwards. It measures the maximum distance between the two parietal bones taken from the leading edge of the skull to the lagging edge i.e. outer to inner. It can also be measured from outer to outer table of the skull.

Studies report that growth of the skull in the mid trimester is linear and rapid and biological variation at each week of gestation is small. The measurement of BPD from 14-26 weeks predicts the correct duration of gestation to the extent of ± 9 days in 95% of cases. However, the measurement of BPD in second trimester (16-20 weeks) routine scan is performed in all good antenatal centers.

At times when the fetal head may be short and wide (brachycephaly) or long and flattened (dolichocephaly), the assessment of age from BPD will be under or over estimated. Therefore, if the shape of head appears brachicephalic or dolichocephalic, the cephalic index is calculated, and if found to be outside the normal range the head circumference should not be used to estimate age.

Cephalic index = $\dfrac{\text{Biparietal diameter X 100}}{\text{Occipito frontal diameter}}$

(Normal Range = 75-85%)

Head Circumference (HC) *:* This parameter is used in the third trimester along with other parameters such as FL. It is measured at the same level at which BPD is taken by using the ellipsoid mode of the machine and adjusting the ellipsoid calipers to the outer margin of the skull table. The accuracy of this parameter is ±2-3 days with 95% confidence interval.

Abdominal circumference (AC): This ultrasonic fetal biometric parameters is less used for assessment of GA. adjusting the ellipsoid calipers to the outer margin of the skull table. The accuracy of this parameter is ±2-3 days with 95% confidence interval.

Kidney Length: Measurement of Kidney length can be done reliably beyond 18 weeks of gestation, both by transabdominal and transvaginal ultrasound.[2,3,4] In a transverse section through the fetal abdomen the kidneys can be visualized as two circular structures on either side of the fetal spine. In the longitudinal section, they appear as two oval structures in a typical paraspinal location. The fetal kidney appears ultrasonically as a sonoluscent halo of tissue surrounding the somewhat more echo pyelocalyceal sinus.[5]

Fetal Kidney: During the 1st trimester, the kidney appear as hyperechoic oval structures at both sides of the spine (their hyperechogenicity can be compared to that of spleen).[6] This echogenicity progressively decreases. During the second and third trimesters, kidneys are easily identified by imaging the dorsolumbar spine and scanning on either side in parasagittal and transverse axial sections.[7]

III. Materials And Methods

This study was conducted at Netaji Subhash Chandra Bose Medical College, Jabalpur in the Department of Anatomy and Department of Radiology. The subjects were pregnant females attending the Antenatal checkup clinic and who were referred to the Radiology Department for a Routine obstetric Ultrasonography.

Case Selection:- The study consisted of 100 pregnant females between 22 to 39 weeks of gestation with their age ranging from 18-40 years. The study included only uncomplicated pregnancies. The pregnant females who were selected as subjects were normal otherwise healthy women. Only singleton fetus, with complete visualization of atleast one kidney was included in the study.

Inclusion Criteria:-
1. Pregnant females, aged between 18-40 years, attending Antenatal clinic for routine checkup who were referred for routine ultrasonography.
2. Pregnant females with gestational ages (as per LMP) >22 weeks were taken as subjects.
3. Uncomplicated pregnancies with a live fetus were included in the study.

IV. Results & Discussion:

The study involved 100 pregnant females with singleton uncomplicated pregnancies who underwent standard ultrasound fetal biometry and kidney length measurement in their late second and third trimesters. Various fetal biometric parameters were measured including KL, FL, BPD, AC and HC.

Using the International Fetal growth equations for KL, FL, BPD, AC and HC, the gestational age was calculated based on Hadlock's Formulae. [8,9]

Table-1
**Summary of kidney length in mm with gestational age**

GA weeks	KL Mean	KL SD	P value	Min. (mm)	Max. (mm)	SD
22	29.016	1.831	0.000	26.612	32.134	1.938
23	29.215	2.121	0.000	26.918	32.401	1.653
24	30.006	1.494	0.000	27.812	32.815	1.486
25	30.019	1.624	0.000	28.312	33.415	1.393
26	30.024	1.936	0.000	28.613	34.400	2.028
27	30.093	2.212	0.000	27.519	35.250	1.933
28	30.264	1.620	0.000	29.643	35.850	1.486
29	31.274	1.494	0.000	30.651	36.914	1.652
30	32.356	1.758	0.000	31.918	38.550	1.798
31	34.017	1.693	0.001	31.999	39.212	1.635
32	34.393	0.943	0.000	32.450	40.128	0.691
33	35.491	0.842	0.000	32.450	40.222	0.807
34	35.683	0.291	0.000	33.851	40.293	0.816
35	36.517	0.701	0.614	34.917	41.015	0.807
36	37.646	0.691	0.963	36.500	41.798	0.219
37	37.912	0.717	0.004	36.814	42.198	0.343
38	38.614	0.868	0.000	37.683	42.418	0.676
39	40.02	0.918	0.000	37.816	42.914	0.646
40	40.31	0.716	0.000	37.913	43.816	0.912

Table -1 shows the mean renal lengths and their standard deviations for each week from 22 weeks to 40 weeks. Maximum number of cases were found in the 34 weeks (33-35 weeks) [n=16].
Minimum number of cases were in the 40 weeks [n=2].

The range of mean fetal kidney length was from 29.01mm at 22 weeks to 40.31mm at 40 weeks. The mean fetal kidney lengths increased with gestation as follows: –
29.016mm, 29.21mm, 30.00mm, 30.02mm, 30.09mm, 30,26mm, 31.27 mm, 32.35 mm, 34.01mm, 34.39mm, 35.49mm, 35.68mm, 36.51mm, 37.64mm, 37.91mm, 38.61mm, 40.02mm and 40.31mm at 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36,37, 38, 39 & 40 weeks respectively.
It can easily be observed from the table that as the gestation age increases, there is an increase in fetal kidney length and there is a significant difference in the mean fetal kidney lengths compared across 22-40 weeks of gestation. There was a strong correlation between KL and GA as predicted by FL, BPD, AC, and HC.

Graph -1 : Comparison of Fetal Kidney Length Of Present Study with the mean fetal kidney lengths as given by Cohen HL, Cooper T
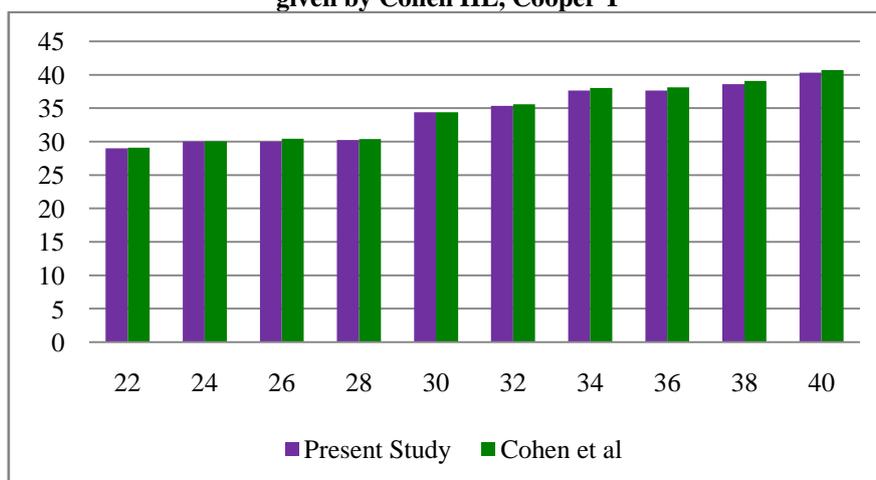
V. CONCLUSION

Kidney length is a more accurate method of determining gestational age than the fetal biometric incidences of biparietal diameter, head circumference, femur length and abdominal circumference between 22 and 40 weeks gestation.[10,11]

When combined with biparietal diameter, femur length, head circumference and abdominal circumference, the precession of dating improved by 2 days.

This observation is in accordance with the conclusion drawn by Cohen H.L. found a linear correlation between fetal kidney length and gestational age.

The present study comprised a sample size of only 100 cases. Such a study on a larger population may establish a National reference value as a new parameters for documentation of gestational age.

With well designed modern equipment, standardized methods and well trained, experienced and conscientious sonographers, it may be possible to eliminate systematic error and reduce random errors. estimation of gestational age, a range of fetal measurements should be made and kidney length should definitely be one of them. The inclusion of fetal kidney length an additional parameter along with the four commonly used fetal biometric parameters will markedly improve the accuracy of gestational age calculation.

From the present study, it can be recommended that for the accurate estimation of gestational age, a range of fetal measurements should be made and kidney length should definitely be one of them. The inclusion of fetal kidney length an additional parameter along with the four commonly used fetal biometric parameters will markedly improve the accuracy of gestational age calculation.

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