ORIGINAL RESEARCH

Role of fetal renal length measurements in estimation of gestational age

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ABSTRACT

Introduction: For the management of obstetric cases, it is very important to know the EDD. But in our set up most of the women do not know the date of LMP and hence it is difficult to predict the EDD. Therefore, ultrasound examination plays an important role in determining the EDD.

Aims: To formulate the ideal length of fetal kidney to the corresponding gestational age and to study of echo pattern of fetal kidney and its correlation with pregnancy outcome.

Materials and methods: 200 pregnant women with known LMP were taken for the study. Gestational age by LMP was calculated and it ranged from 20 weeks to 40 weeks. All the cases were subjected to ultrasound examination. Besides other information through USG, special emphasis was made to calculate USG gestational age by conventional method of measuring BPD. FL. AC. At the same time the renal length and renal medullary echo pattern was examined in all the cases. The cases were grouped according to the gestational age by LMP and mean renal length was calculated for each gestational age group.

Results: It was observed that there was a wide variation in renal length for the gestational age group of 20-30 weeks. This variation narrowed down from the 30-40 weeks of gestational age group. There was a definite correlation between the renal length with the gestational age by LMP. It was found that USG with standard parameters gave ± 3 weeks difference form LMP EDD, whereas the EDD calculated by renal length gave a difference of ± 2 weeks. The prediction interval was narrowed from ±3 weeks to ± 2 weeks when renal length was used instead of the standard USG parameters i.e., there was ± 1 week difference between EDD by renal length and EDD by USG.

Conclusion: Examination of fetal renal medullary echo pattern helps us in identifying high risk pregnancy associated with intrauterine growth restriction and helps us in management decisions.

Keywords: Gestational age, Fetal Renal Medulla, Intrauterine growth restriction

INTRODUCTION

Accurate assessment of gestational age is critical for a variety of diagnostic and management considerations in obstetrical practice. Assessment of gestational age by ultrasonography helps in diagnosis of fetalabnormalities by comparing the size of the fetusand its component parts to the norms for the gestational age. These include skeletal dysplasia, microcephaly. Diagnosis of intra-uterine growth restriction is made in part by estimating the fetal weight and assessing its percentile for the gestational age Interpretation of the maternal serum triple

screen (HCG. alpha fetoprotein and oestriol) also require knowledge of the gestational age because the normal levels of these substances vary with age. [1,2]
Management decisions about the timing of delivery can best be made if gestational age is accurately known. The knowledge of the gestational age will preclude the possibility of iatrogenic premature delivery in patients undergoing elective caesarean section. In patients with preterm labour. knowledge of the gestational age will influence the use of tocolytics, the use of steroids to accelerate fetal lung maturity. the timing of amniocentesis for evaluating fetal lung maturity and the type of institute in which delivery should take place eg: primary versus tertiary care centre.[3,4]Precise knowledge of the gestational age will also help the obstetrician to avoid a pregnancy of post term and its attendant risk to the foetus. Our aim is to formulate the ideal length of fetal kidney to the corresponding gestational age and to Study of echo pattern of fetal kidney and its correlation with pregnancy outcome.

MATERIALS AND METHODS

It is prospective study done in 200 pregnant women of Yashoda Super speciality hospital were selected for this study. The women who underwent antenatal ultrasound who met thefollowing criteria were taken into the study.

INCLUSION CRITERIA

Women with Known LMP, Gestational age of > 20 weeks , Singleton pregnancy, Full outline image of normal fetal kidney

EXCLUSION CRITERIA

Multiple pregnancy, Neutral tube defects of foetus, Anomalies of fetal kidney, Foetuses of diabetic and eclamptic mothers, Renal pelvic dilation more than 4 mm in AP diameter, Unclear adrenal or renal borders.
The ultrasound machine used had 3 5 MHz transducer probe. there are two types of machine. All the scans were done by using transabdominal approach. In this cross-sectional study, the study group consisted of LMP determined gestational age of foetuses ranging from 20 weeks till 40 weeks. Only one USG report of each patient was taken into study.
During the routine antenatal scan i.e., measurement of BPD, FL, Ac, liquor amount. placental grading etc, fetal renal length and fetal renal medullary echo pattern was also measured simultaneously. Renal length was measured in the sagittal view only if there were no anomalies noted . The measurements were obtained by measuring the renal length from upper pole till lower pole taking care not to include the adrenal gland while taking the reading. The difference between the measurements of both renals in the same foetus was found to be insignificant, hence only one kidney was measured per foetus the kidney to be measured was selected depending upon the ease of visualization. After obtaining the readings, a retrospective study was done to test the hypothesis that fetal kidney length is an age dependent variableand hence can be used to predict the gestational age and cases with increased fetal renal medullary echo-pattern are analysed. In the end the regression equation was used to predict the gestational age and the results compared with that of LMP determined EDD and USG determined EDD in 50 follow up cases.

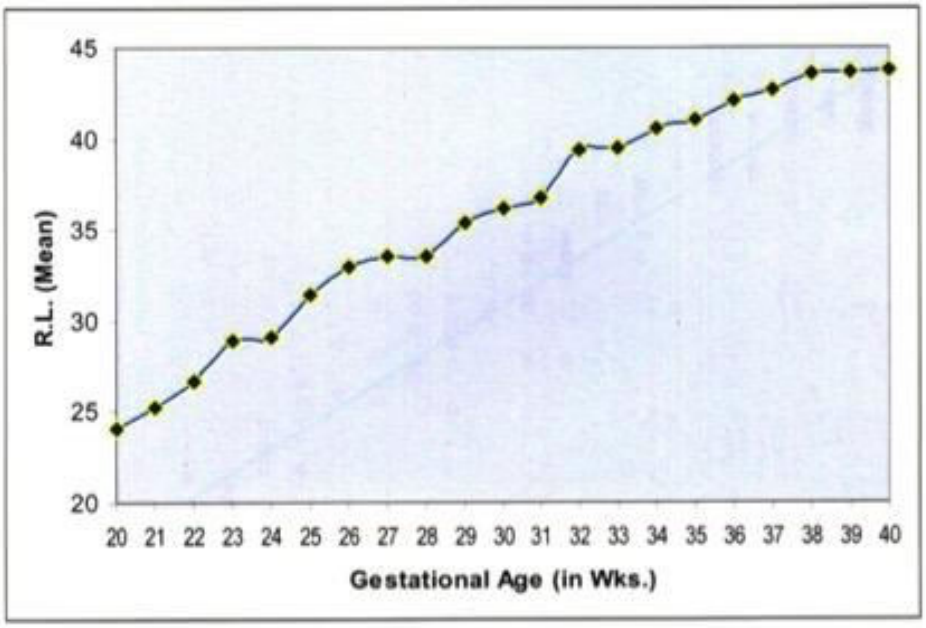
STATISTICAL ANALYSIS

Least squares method was used to fit the relationship between gestational age and fetal biometric parameters. For this purpose SPSS WINDOWS VERSION 15.0 was used
Prediction equation compared on the basis of coefficient of determination (R^2).

RESULTS

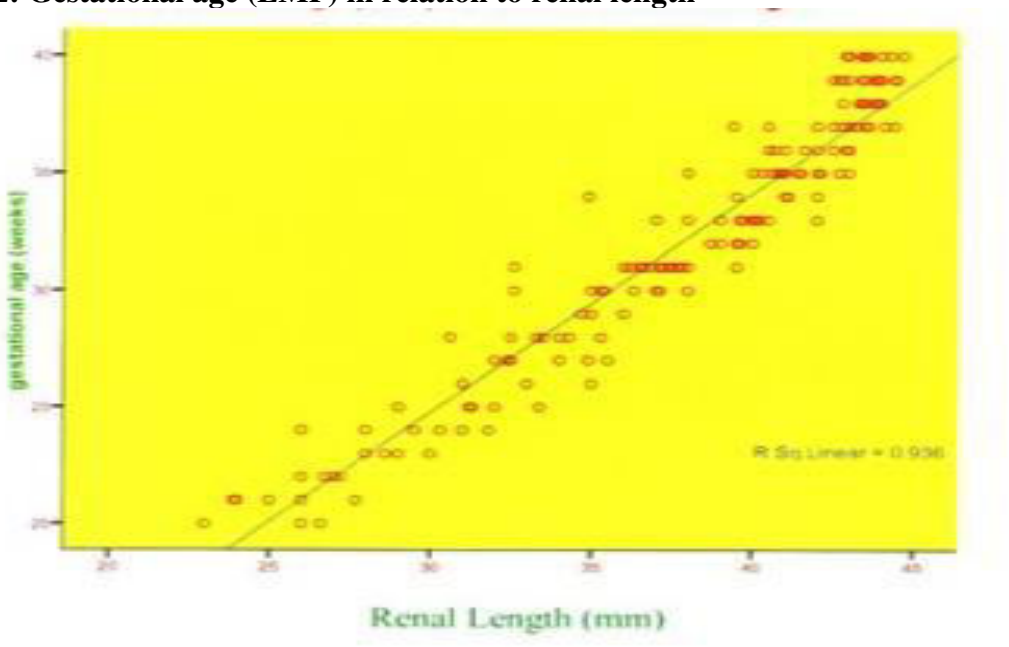
In the present study, 200 pregnant women were selected who had known LMP and a singleton gestation. The gestational age of foetuses ranged from 20-40 weeks as determined by the LMP. All these pregnant women were subjected to routine ultrasound examination, along with the measurement of the routine ultrasound parameters; the renal length and renal medullary echo pattern of individual foetuses were also examined. The renal measurement was then used to prepare a normogram for gestational ages ranging from 20 to 40 weeks and predict gestational age by formulating a regression equation.

Figure-1: Renal length in relation to gestational age



It was also observed that from 20 weeks till 30 weeks, there were wide variations in the measured renal length, whereas the variation decreased considerably from 30 weeksonwards.

Figure-2: Gestational age (LMP) in relation to renal length



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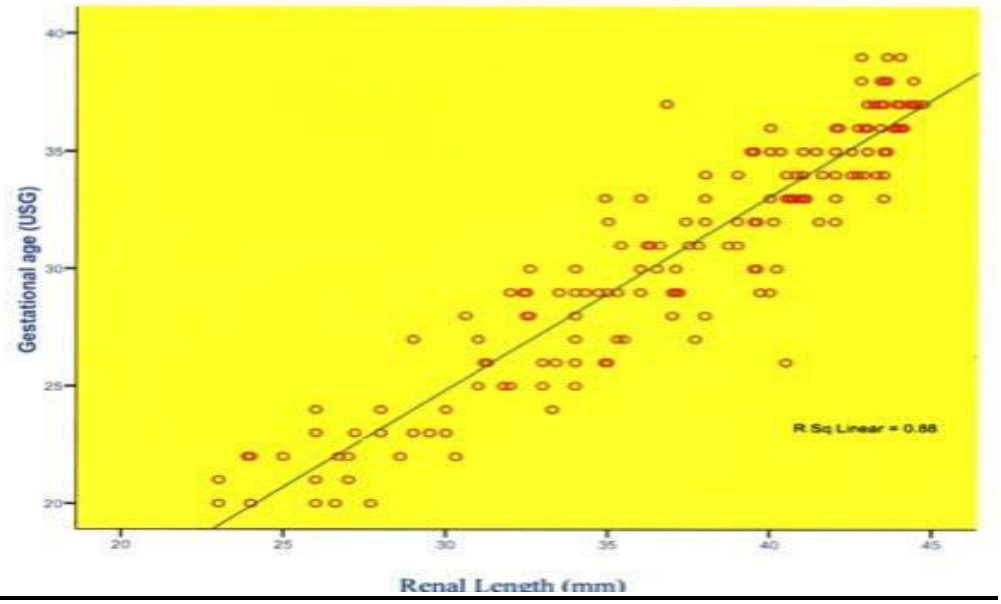
Here also it's clearly seen that there is a wide variation in the measured renal length prior to 30 weeks, while variability decreased dramatically from 30 weeks onwards.

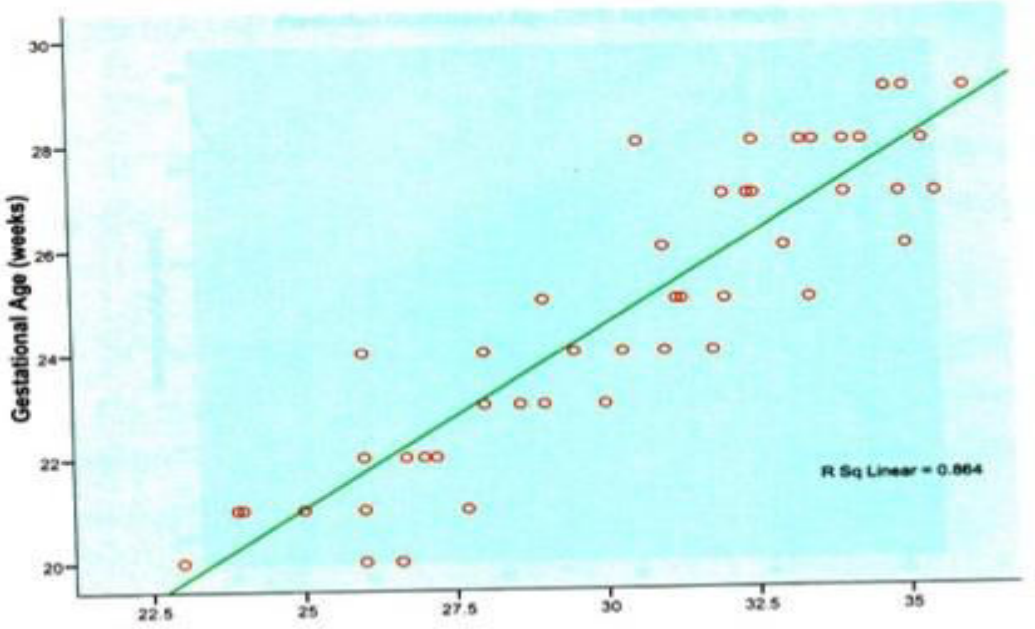
Figure-3: Gestational age(USG) in relation to renal length(cm)



The X axis represents the renal length (in mms) whereas the Y axis represents the gestational age (in weeks). It is observed that there is a linear increase in the renal length measurements as the fetal gestational age advanced. Therefore, it can be inferred that renal length is a dependent variable of the gestational age as determined by the LMP.

The renal length (in mms) is plotted on X axis and gestational age determined by ultrasound parameters (BPD,FL and AC) is plotted on the Y axis. It is observed that the renal length showed a linear progression in relation to USG determined gestational age. Although there was more variability till 30weeks ,the degree of variability decreased steadily from 30weeks onwards and was found to be low at term.

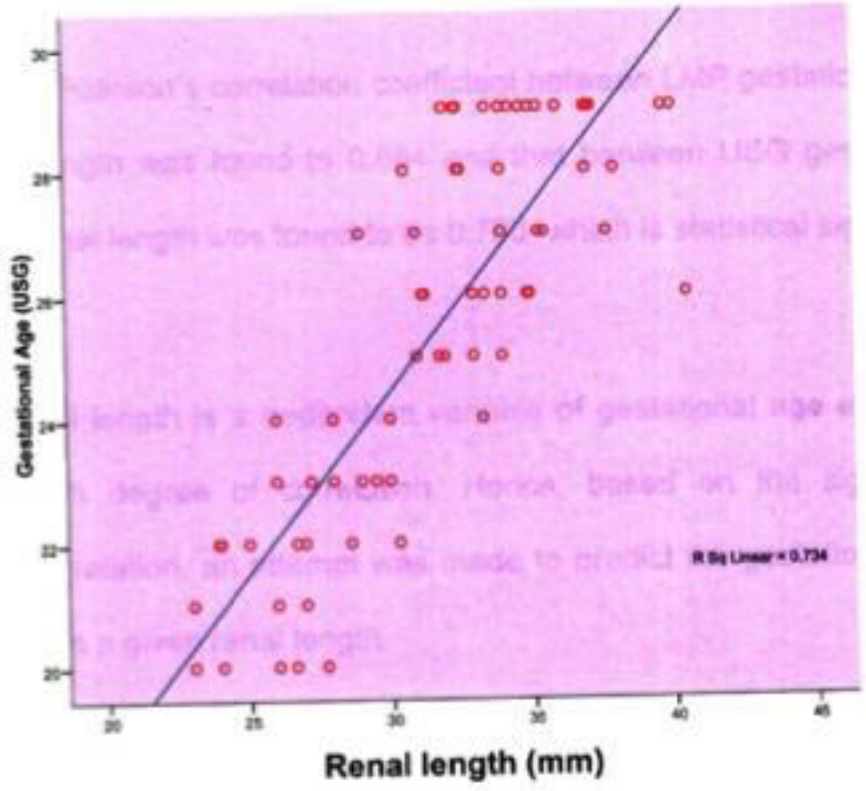
Figure-4: Prediction of gestational age (LMP) by renal length(Group-A < 30 weeks)



The renal length (in mms) is plotted on the X axis and gestational age by LMP (in weeks) is plotted on Y axils. The scatter points represent the actual LMP determined gestational age and the measured renal lengths. The mean renal length measurement was equated in the regression equation (1) and the predicted gestational age plotted on the graph. The predicted

gestational age derived from mean renal length measurements were then connected with a solid line. The line so obtained was sound to have a linear progression. It was also seen that the variability between the actual LMP gestational age and renal length was minimum.

Figure-5: Prediction gestational age(USG) by renal length(Group-A < 30 weeks)



Renal length (in mms) is plotted on the X axis and USG determined gestational age (in weeks) on the Y axis. The scatter points represent the USG determined gestational age and the measured renal length. The mean renal lengths were then equated in the regression equation No. 2 and the predicted gestational age plotted on the graph. When all the predicted gestational ages were joined together, a linear progressive line was obtained. Although there is a linear progression, the degrees of variability between the actual and the predicted gestational age was found to be high.

GROUP B (> 30 WEEKS GESTATIONAL AGE)

The study group of >30 weeks gestational age comprises of 136 fetuses with LMP determined gestational age of 30 weeks and more

The Pearson's correlation coefficient between LMP gestational age a renal length was found to 0.884 and that between USG gestational age and renal length was found to be 0.766 which is statistically significant ($p<0.01$).

Renal length is a dependent variable of gestational age as noted by the high degree of correlation. Hence. based on the significant positive correlation, an attempt was made to predict the gestational age of foetus from a given renal length. A regression equation was formulated after regressing gestational age as determined by LMP and ultrasound on the renal length.

Table-1: Descriptive and comparative statistics of correlation analysis

Formula	R^2	S.E
3.$GA_{(LMP)}$=- 5.5 + 0.994(RL)	73%	+/-1.63
4.$GA_{(USG)=}$ -5.81+0.696(RL)	60%	+/-1.55

Analysis of graph 1, 2 and 3 shows that there is a wide variability between the measured renal lengths and the corresponding gestational ages. (LMP determined) from 20 weeks till 30 weeks. From 30 weeks onwards the degree of variability between renal length and the gestational age (LMP) decreased considerably this could be due to the increasing ease to identify the kidney length after 30 weeks. Hence the study group was divided into two groups
Group A : Fetuses with LMP gestational age of < 30 weeks
Group B Fetuses with LMP gestational age of 30 weeks

GROUP A(<30 WEEKS GESTATONAL AGE)

This study group consists of 64 foetuses with LMP gestational age of < 30 weeks (i.e. fetuses with gestational age of 30 weeks are not included in this group). In this study group. the Persons correlation coefficient between renal length and the LMP gestational age was found to be 0.938 and that between renal length and USG gestational age it was 0.860 which is statistically significant ($p<0.01$). It was therefore inferred that renal length is a dependent variable of gestational age determined either from LMP or ultrasound.

Based on this observation, an attempt was made to determine the gestational age of a foetus when a particular renal length is given and the LMP is either unknown / unreliable or when there was discrepancy between the ultrasonic biometric parameters regarding gestational age.

A regression equation was then formulated by regressing gestational age as determined by LMP and ultrasound (USG) on the length using the regression coefficient.

Table-2: Descriptive and comparative statistics of correlation analysis.

Formula	R^2	S.E.
$GA_{(LMP)}$= 3.65 + 0.70 (RL)	86%	+/-1.07
$GA_{(USG)}$= 6.83 +0.586(RL)	73%	+/-1.63

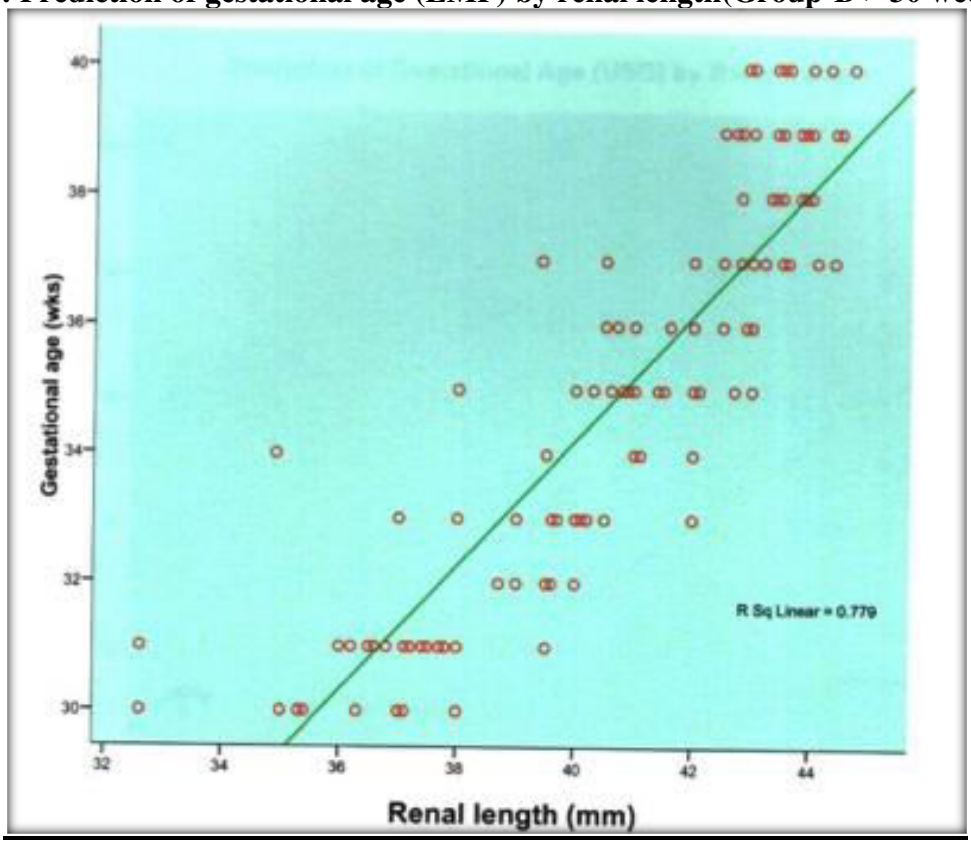
Table-3: Relationship between Renal Length and Gestational Age (Group A < 30 weeks)

G.A. LMP	Correlation between	No. of Cases	Correlation coefficient	Regression coefficient	Prediction of GA for RL		
					Regression Equation	R^2	SE
< 30 WEEKS	RL and	64	---	----	--	---	--
	G.A. (LMP)	64	0.93 ($p < 0.001$)	0.70	GA=3.65+0.70(RL)	86%	1.07
	G.A. (USG)	64	0.86 ($p < 0.001$)	0.58	GA=6.83+0.586(RL)	73%	1.63

Table-4: Relationship between Renal Length and Gestational Age(Group B > 30 weeks)

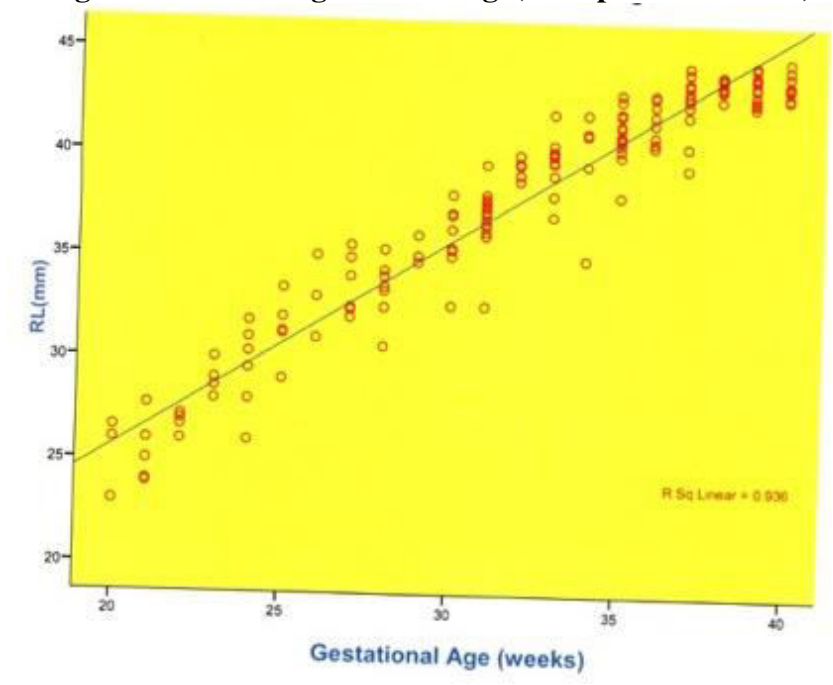
G.A. LMP	Correlation between	No. of Cases	Correlation coefficient	Regression coefficient	Prediction of GA for RL		
					Regression Equation	R^2	SE
≥ 30 weeks	RL and	136	-	-	-	-	-
	G.A. (LMP)	136	0.88 ($p<0.001$)	0.99	GA= -.5+0.994(RL)	77%	1.51
	G.A. (USG)	136	0.76 ($p<0.001$)	0.69	GA=5.81+0.696(RL)	60%	1.55

Figure-6: Prediction of gestational age (LMP) by renal length(Group-B > 30 weeks)



The renal length (in mms) is plotted on the X axis and gestational age (by LMP) in weeks is plotted on the Y axis. This scatter points are actual gestational age and the measured renal length. The mean renal length measurement was equated in the regression equation No.3 and the predicted gestational age obtained. The predicted gestational age for each mean renal length was then plotted on the graph and joined with each other: it was found that there was a linear progressive line. Also, the variability between the actual gestational age and the predicted gestational age was found to be minimum.

Figure-7: Renal length in relation to gestational age(Group-B > 30 weeks)



Renal length (in mms) is plotted on the X axis and USG determined gestational age (in weeks) on the Y axis. The scatter points represent the USG determined gestational ageand the measured renal length. It was found that the standard USG parameters gave a ±3 weeks difference whereas the prediction interval calculated by using renal length gave a ±2 weeks difference from the LMP determined EDD.

DISCUSSION

In the present study, 200 pregnant women with known LMP and gestational age ranging from 20 weeks to 40 weeks were subjected to routine antenatal scan. Besides noting the anatomy of the foetus by usual measurements of BPD, FL and AC, renal length and renal echo pattern of the foetus were also measured. During the study, it was observed that in fetuses less than 20 weeks, the renal outline is barely visible and it's difficult to delineate them due to their small size and lack of perinephric pad of fat. As the gestational age progresses, with the subsequent deposition of perinephric fat. increase in the echogenicity of the fetal kidney makes it more visible and delineates it from the surrounding soft tissues .

It was also found that there is insignificant difference between the measurement of both the kidneys of a single foetus, hence only one kidney per foetus was measured provided there are no renal anomalies. The measurement of renal length was done in the sagittal view. When there was difficulty in visualization of the renal due to fetal rib shadow / adrenal glands: in such cases, the better visualized kidney wasmeasured. However, in case of maternal obesity view of both the kidneys were hampered. [5]

The transducer of the USG probe was positioned so as to obtain a correct alignment i.e., by noting the asymmetry between the visualized renal pyramid in relationship to the imaged kidney. This was done to avoid shortening of the measured renal length. After obtaining all the measurements, normogram was constructed using the renal lengths measured for the specific gestational age. It was found that as the gestational age progressed, there was a linear increase in the renal length of the foetus too. [6,7]

The normogram constructed by using the measured renal lengths were compared with that of Cohen et al.,[8] no significant difference was found regarding the mean renal length measurements. Hence renal length can be applied to different racial population for determination of gestational age.

When the normogram was plotted on a graph, a wide range of variation was found between renal length and the gestational age in the gestational age group of 20-29 weeks. This variation was narrow for the gestational age group of 30 weeks and beyond.

Therefore, the study group was divided into two groups.

Group A: Consisting of fetuses of < 30 weeks, the correlation coefficient between renal length and gestational age was found to 0.93.

Group B: Consisting of fetuses of >30 weeks, the correlation coefficient between renal length and gestational age was found to 0.88. Depending upon the correlation coefficient, regression equation was formulated.

	R^2
< 30 weeks GA = 3.65 + 0.70 (RL)	86%
>30 weeks GA = - 5.5 + 0.994 (RL)	77%

The coefficient of determination for > 30 weeks age group was found to be 77% as compared to Pandey et a1[9] study 96.4% this difference could be due to the larger sample size used in the present study. The prediction interval was found to be ±2 weeks which is the same as that of Pandey et al'.

The formula used depends upon the renal length.

GA = 3.65 + 0,70 (RL) ± 1.07---- for RL length<36.15mm.

GA = - 5.5 + 0.994 (RL) ± 0.994 for RL length>36.15mm.

In the follow up group of 50 cases, gestational age predicted by the standard ultrasound parameters (BPD, FL and AC) and that obtained by renal length using the appropriate formula were noted down. Accordingly, EDD by both methods were arrived at. Oncomparing the results with theknown LMP EDD, it was found that EDD by standard ultrasound parameters, differed from the LMP EDD by + 3 weeks whereas the EDD obtained by renal length differed by ± 2 weeks from the LMP EDD. Hence renal length can be used to predict the gestational age of the foetus in the 30 trimesters better than the standard ultrasound parameters (±3 weeks).

Based on the high degree of correlation between the gestational age (LMP) and the renal length, regression equations were formulated by regressing gestational age on renal length. These results are in agreement to those obtained by Pandey et al.'[81] To test the accuracy of prediction of gestational age by renal length. 50 cases i.e., pregnant women were followed up. All the women knew their LMP, gestational age was then determined by ultrasound parameters. Renal length was measured and using the formula No 3 (GA>30 weeks), gestational age predicted. The EDD calculated from USG gestational age and renal length estimated gestational age was compared with the EDD obtained by LMP.Pandey et al[10] did a study on 98 cases of > 30 weeksgestational age to determine the gestational age by using renal length. The correlation coefficient between gestational age by LMP and the renal length measured from fetuses observed in Pandey at a1 and the present study are presented.[10]

Both the studies show a high degree of correlation between gestational age (LMP) and the renal length of the foetus.Out of 200 cases selected for study 12 cases of intrauterine growth restriction were diagnosed in that 4 cases had increased renal medullary echo pattern which accounts to 30% of cases and the results are comparable to Araújo et a1[11].

The coefficient of determination (R^2) was found to be high in both thestudies when gestational age was regressed on the renal length. The present study using SPSS WINDOWS VERSION 15.0 estimated the mean prediction interval to be ± 2 weeks when renal length was used to determine the gestational age. Among the 4 cases of increased renal echo pattern found in intra-uterine growth restriction cases, 2 cases had intrauterine death and 2 cases needed to be terminated early in view of fetal compromise.

Out of 200 cases selected for study 12 cases of intrauterine growth restriction were diagnosed in that 4 cases had increased renal medullary echo pattern which accounts to 30% of cases and the results are comparable to Araújo et al[11]. Among the 4 cases of increased renal echo pattern found in intra-uterine growth restriction cases, 2 cases had intrauterine death and 2 cases needed to be terminated early in view of fetal compromise.Hence addition of fetal renal length plays important role in estimation of gestational age, as USG assessment of gestational age by standard parameters show more discrepancy as pregnancy advances. Examination of fetal renal echo pattern also helps in management of high risk cases like intrauterine growth restriction.

CONCLUSION

USG assessment of gestational age by standard parameter show discrepancy as pregnancy advances, so addition of renal length for estimation of gestational age will improve the accuracy of assessment of gestational age by ultrasonography. Examination of fetal renal medullary echo pattern helps us in identifying high risk pregnancy associated with intrauterine growth restriction and helps us in management decisions.

REFERENCES

1. Gottlieb AG, and Galan HL. Nontraditionalsonographic pearls in estimating gestational age.SeminPerinatol 2008; 32: 154-60.

2. Konje JC, Abrams K R,Bell SC, et al. Determination of GA after the 24th week of gestation from FKLmeasurements. Ultrasound ObstetGynecol 2002; 19: 592-97.
3. Yusuf N, Moslem FN, Haque JA, et al. Fetal kidney length: Can be a new parameter for determination of GA in 3rd trimester. TAJ 2007; 20(2): 147-50.
4. Shin JS, Seo YS, Kim JH, et al. Nomogram of fetal renal growth expressed in length and parenchymal area derived from ultrasound images. J Urol 2007; 178: 2150-54.
5. Singh A, Singh G, Gupta K. Estimation of Gestational Age by Using Fetal Kidney Length and Transcerebellar Diameter in Comparison with Other Biometric Indices. Donald School J Ultrasound ObstetGynecol 2021;15(1):4–9.
6. Sharma R. Comparative accuracy of transcerebellar diameter and crown rump length for estimation of gestational age. Int J Med Imag 2017;5(3):38–41.
7. Peter M, Nayak A, Giri P, et al. Fetal kidney length as a parameter for determination of gestational age from 20th week to term in healthy women with uncomplicated pregnancy. Int J Res Med S 2017;5(5):1869–1873.
8. Cohen HL, Cooper J, Eisenberg P, et al. Normal length of fetal kidneys: sonographic study in 397 obstetric patients. AJR Am J Roentgenology 1991;157(3):545–548. DOI: 10.2214/ajr.157.3.1872242.
9. Ninan VT, Koshi KT, Niyamthullah MM, Jacob CK, Gopalakrishnan G, Pandey AP, et al. A comparative study of methods of estimating renal size in normal adults. *Nephrol Dial Transplant.* 1990;5:851–4.
10. Pandey R, Jacob A, Brooks H . Acute pancreatitis in pregnancy: review of three cases and anaesthetic management. *Int J ObstetAnesth* 2012; **21**: 360–363.
11. Araújo, N.C., Rebelo, M.A.P., da Silveira Rioja, L. *et al.* Sonographically determined kidney measurements are better able to predict histological changes and a low CKD-EPI eGFR when weighted towards cortical echogenicity. *BMC 2020: Nephrol* **21,** 123.