

**FOETAL KIDNEY LENGTH – AN ADDITIONAL  
PARAMETER FOR DETERMINATION OF  
GESTATIONAL AGE**

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## **CERTIFICATE**

This is to certify that the dissertation titled **“Foetal Kidney Length – An Additional Parameter For Determination Of Gestational Age”** is a bonafide work done by Dr.R. Rijaphin, Government R.S.R.M. Lying in Hospital, Stanley Medical College to the Faculty of Obstetrics and Gynaecology, The Tamilnadu Dr. M.G.R. Medical university, Chennai in partial fulfillment of the requirement for the award of M.D. Degree (Obstetrics and Gynaecology) is a bonafide research work carried out by here under our direct supervision and guidance.

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## INTRODUCTION

One of the commonest problems that an obstetrician faces frequently is estimation of fetal maturity. An accurate estimation of gestational age is fundamental to the management of all pregnancies, especially prolonged pregnancy and other high risk pregnancies. In some cases early termination is necessary as soon as fetus becomes mature eg. preeclampsia, IUGR, diabetes. Accurate estimation of GA is also necessary in antenatal testing like chorionic villus sampling and successful planning of appropriate therapy or intervention.

The duration of pregnancy is 9 calendar months + 7 days/40 weeks/280 days which is calculated from the 1<sup>st</sup> day of last menstrual period in women with 28 days cycle.

Unfortunately, sometimes calculation of EDD based on LMP becomes very difficult when

- a) The menstrual cycle is irregular.
- b) Patient fails to remember LMP/reports inaccurately.
- c) Pregnancy occurs during lactational amenorrhoea.
- d) If patient had bled in early pregnancy.

**Ultrasonic measurement of fetal biometry(BPD,FL,CRL)** are considered to be reliable in first and early 2<sup>nd</sup> trimester. Currently there is no single fetal measurement for accurate estimation of gestational age in the 3<sup>rd</sup> trimester especially in women who booked late and unsure about LMPs.

Several longitudinal studies have been performed in the west concerning sonographic measurement of fetal kidney length. Initially these were done for diagnosis of renal malformation in utero and later on they were to find out the correlation between fetal kidney length and gestational age. Hence this study is to establish this linear correlation.

## **REVIEW OF LITERATURE**

Knowledge of gestational age is important because it can affect clinical management in a number of ways

- 1) Early pregnancy – scheduling chorionic villus sampling (9-12 weeks).
- 2) To anticipate normal spontaneous delivery or to plan for elective delivery with the time frame of a term pregnancy.
- 3) In evaluation of fetal growth

The reliability of EDD may be excellent, good /poor.

### **Excellent dates**

- 1) Patients with adequate clinical information (known, normal LMP 28 -30 days cycle, no recent use of OCP, uterine size in agreement with dates) USG examination between 16 and 24 weeks.
- 2) Patients with inadequate clinical information but with two USG examination between 16 and 24 weeks showing linear fetal growth.



### **Good dates**

1) Patients with adequate clinical information and USG after 24 weeks of gestation.

2) Patients with inadequate clinical information, 2/more ultrasound examination showing adequate growth and similar EDD.

### **Poor dates**

1) Patients with inadequate clinical information and no USG available.

USG fails in adequate determination of GA in the third trimester due to large variability in biometric parameters.

### **The elements involved in clinical estimation of GA are**

**1) Last menstrual period**

The patient's menstrual history is considered adequate for the purpose of establishing EDD only if LMP was normal in duration, amount of flow, if prior menstrual periods were at regular intervals and if the patient did not use OCP within 3 months of her LMP.

### **Naegele's rule**

Add 7 days to 1<sup>st</sup> day of LMP and count back 3 months.

### **2) A positive urine pregnancy test**

If a patient has a positive pregnancy test after 4-5 weeks of amenorrhoea the patients dates become firmly established.

### **3) Date of quickening**

If this can be ascertained definitely,

Multi – 22 wks + date of quickening

Primi - 20 weeks + date of quickening = date of confinement.

### **4) Symphysiofundal height**

After 24 weeks the symphysiofundal height in cm approximates to the number of weeks up to 36 weeks of gestation but a number of factors influence the measurement including multiple pregnancy ,IUGR, diabetes, obesity, fetal lie, engagement, inter and intra observer variation.

### **Mc donald's rule**

Duration of pregnancy – ht of fundus (cm) x 2/7 = duration of pregnancy in lunar months.

Ht of fundus (cm) x 8/9 = duration of pregnancy in weeks.

### **5) Abdominal girth measurement**

Girth is measured and recorded at every visit from 30 weeks onwards

At 30 weeks – girth is 30 inches.

At 40 weeks – girth is 40 inches.

### **6) Palpation of fetal head**

Size of head, width of sutures and fontanel, degree of mobility.

### **7) state of cervix**

### **8) x ray estimation of ossification centres**

37 weeks – ossification centre of lower end of femur.

40 weeks – ossification centre of both upper end of tibia and lower end of femur.

### **9) Ultrasonic measurement of fetal biometry(BPD,FL,CRL)**

## **Ultrasound in obstetrics**

The impact of ultrasonography in the practice of obstetrics has been profound. Ultrasonic methods for evaluating the fetus are now employed widely.

A carefully performed ultrasound examination reveals vital information about

- fetal anatomy
- fetal environment<sup>2</sup>
- fetal growth
- fetal well being

with no confirmed biological hazards.

Ultrasound technology has evolved from producing images of pregnancy to measuring maternal and fetal circulatory function.

The acoustic condition of ultrasound used in humans are a sound wave intensity of  $100\text{mv}/\text{cm}^2$  and a frequency of 3-5 MHz and an exposure time  $<30$  min, and no side effects are seen. Hence ultrasound appears safe enough to be used.

Under experimental condition of intensity more than  $100\text{mv}/\text{cm}^2$  and continuous exposure, the following bioeffects may be seen.

- macronodular degeneration in vitro
- cellular effects such as cell membrane changes, increased proteins and DNA synthesis.
- Genetic damage(mutation)
- Sister chromatid exchange (SCE) probably due to DNA repair after cell damage.

The American institute of ultrasound in medicine approved the following statement on clinical study in October 1983.

“No confirmed biological effects on patients or instrument operators caused by exposure at intensities typical of present diagnostic instruments have ever been reported. Current data indicates that the benefits of the patients, of the prudent use of diagnostic ultrasound outweighs the risk of any, that may be present”.

### **Convenience of an ultrasound**

Ultrasound in an antenatal women has become one of the important investigation that is routinely done nowadays. There are 2 stages during a normal pregnancy when USG will be most useful and provide the most information.

These stages are

1. at 18-22 weeks after the first day of the woman's LMP
2. at 32-36 weeks after the first day of the woman's LMP

What is important in 18-22 weeks scan ?

This is the best time

1. to establish the gestational age accurately.
2. to diagnose fetal abnormalities.
3. locate placenta.
4. recognize myomas or other associated pelvic mass that may interfere with pregnancy or delivery.

What is important in 32-36 weeks scan ?

This is best time to

1. recognize intrauterine growth retardation.
2. fetal anomalies missed at first scan.
3. confirm presentation and position of fetus.

4. locate placenta accurately.
5. assess amount of amniotic fluid.

So along with this, kidney length can be measured in the 3<sup>rd</sup> trimester scan and maturity of foetus can be confirmed.

### **USG parameters to date pregnancy**

#### **1<sup>st</sup> trimester**

Gestational sac – 5weeks

Gestational sac + fetal pole – 6 weeks

Crown rump length

#### **2<sup>nd</sup> trimester**

Bi parietal diameter

Abdominal circumference

Head circumference

Femur length

## **Accuracy in**

1<sup>st</sup> trimester -  $\pm 3$  days

2<sup>nd</sup> trimester -  $\pm 1/2$  weeks

3<sup>rd</sup> trimester -  $\pm 2/3$  weeks

## **Other parameters to date pregnancy**

Floating particles in amniotic fluid

Trans coelomic diameter

Trans cerebellar diameter

Ossification centers of long bones

Clavicular length

Foot length

Thoracic abdominal diameter ratios



## **1<sup>st</sup> trimester dating**

1) **Gestational sac** – from 5<sup>th</sup>–11<sup>th</sup> week of pregnancy mean diameter and volume of gestational sac is measured. Sac is 1<sup>st</sup> visualized at 5 weeks and its diameter increases at the rate of 7- 11 mm per week to reach 5-6 cm in 10<sup>th</sup> week.

Gestational sac volume-  $0.55 \times D1 \times D2 \times D3$

D1, D2, D3 - transverse, antero posterior, longitudinal diameter of sac.

## **2) Crown rump length**

Rule of thumb- Add 6.5 cm to CRL measured in cms = GA

Valuable between 8- 12 weeks.

## **2<sup>nd</sup> & 3<sup>rd</sup> trimester dating**

### **1) Biparietal diameter - >12 weeks**

Most commonly accepted plane is cross section parallel to the canthomeatal line and slightly above it which include falx, thalamus, cavum septum pellucidum

Between 21 – 30 weeks – accuracy -  $\pm 11$  days

After 31 weeks – accuracy  $\pm$  15 days

Growth of BPD/week-

13 – 20weeks = 3-4 mm

21- 28 weeks=3mm

29-32 weeks=2-3 mm

32- term-2 mm

### **Invalid BPD**

IUGR

Moving fetus

Hydramnios

Breech presentation

Occipito posterior position

Hydrocephalus

Microcephaly

Deeply engaged head

## **2) Head circumference**

$$HC = (BPD + \text{occipitofrontal diameter}) \times 1.62$$

HC > predictable than BPD near term , least accurate before 26 weeks.

## **3) Abdominal circumference**

Worst predictor than BPD except during 36-42 weeks where it is more accurate than BPD.

## **4) Femur length**

Measured from greater trochanter-lateral condyle ,head of femur not included.

Average FL at term – 7.4 – 7.7 cm.

## **5) Recent –kidney length**

### **Anatomy & development of kidneys**

Kidneys are a pair of excretory organs situated on the posterior abdominal wall one on each side of the vertebral column behind the peritoneum.

**Location:**

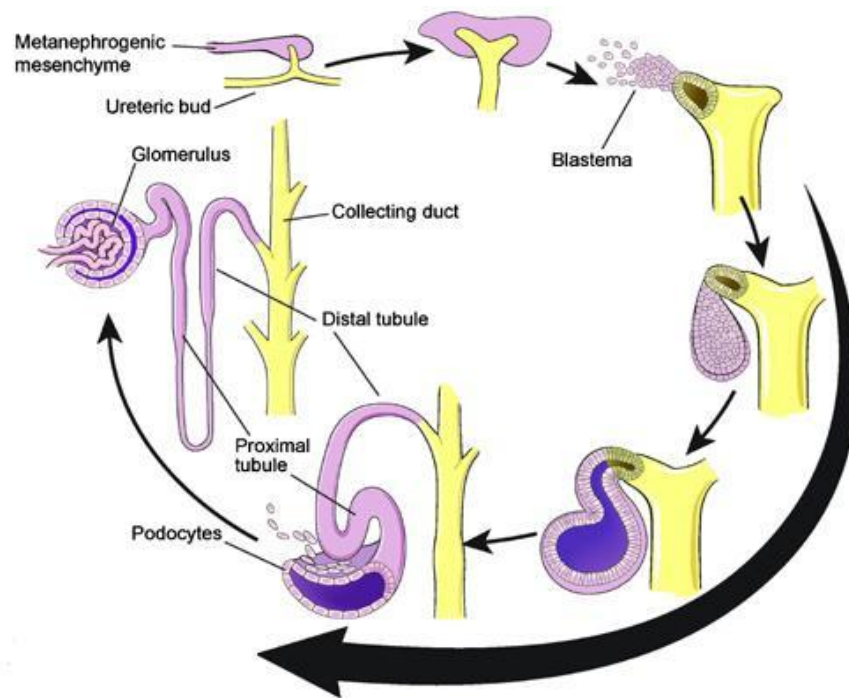
In adult, the kidneys occupy epigastric, hypochondriac, lumbar and umbilical regions. Vertically, they extend from the upper border of T12 vertebra to the centre of the body of L3 vertebra. The right kidney is slightly lower than the left, and left kidney is a little nearer to the median plane than the right.

In the foetus, the kidney is lobulated and is made up of 12 lobules. After birth the lobules gradually fuse, so that in the adults the kidney is uniformly smooth. However, the evidence of foetal lobulation may persist.

- A) The metanephric blastema develops on each side of the body early in the 5<sup>th</sup> week.
- B) The ureteric bud grows out to the metanephric blastema.
- C) The ureteric bud bifurcates to produce superior and inferior lobes in the metanephros.
- D) Additional lobules form during the next 10 weeks.

The secretory part(nephron) of the kidney, except for glomerulus develops from the metanephros, and the collecting part from the uretric bud arising from mesonephric duct. The kidney develops in the sacral region (pelvis) but later on it ascends to its adult position.

## Diagram



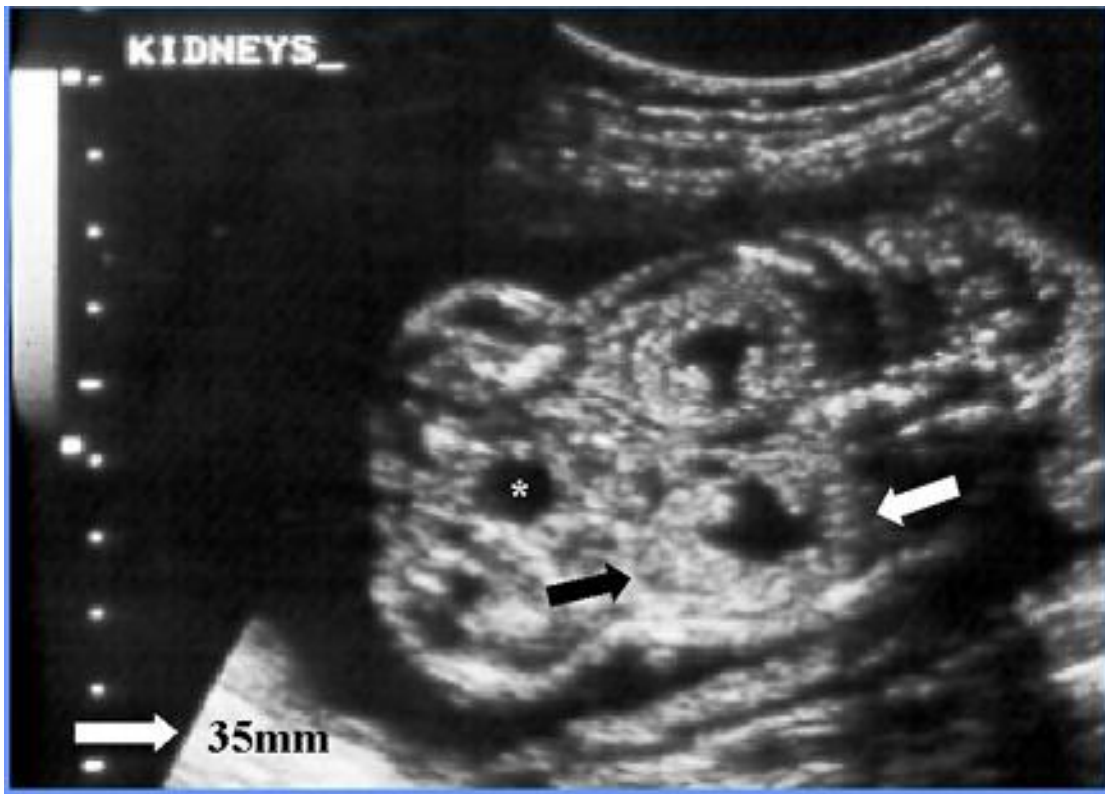
### Fetal kidneys

Fetal kidneys are not seen until 15 weeks of gestation

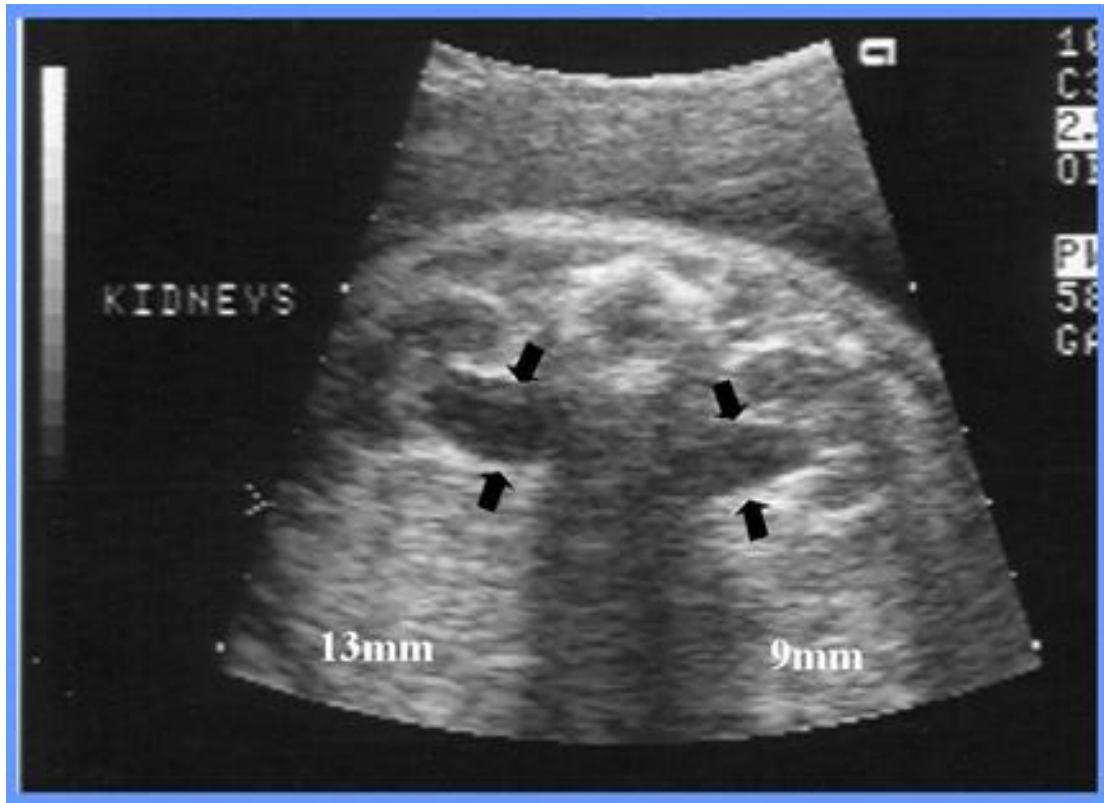
After 17 weeks- fetal kidneys are 90% imaged. After 28 weeks there is sufficient fat surrounding and accentuating the normal sonoluscent renal parenchyma to make identification simple. Fetal kidneys grows at the rate of 1.7mm fortnightly.

**Diagram:**

**Sagittal plane**



## Coronal plane



In USG they appear as hypoechoic circular structures on either side of spine within them can be seen strongly echogenic renal pelvis. The capsule is also echogenic, the renal pyramids are hypoechoic and can appear large. Some dilatation of renal pelvis less than 5mm may be seen but is normal finding.

The ultrasound used in my study is GM HEALTH CARE SYSTEM 4-5Mhz.





## **LITERATURE ANALYSED:**

J J Kausaria et al in 2009 analysed 70 women who were certain of their LMP and who had regular menstrual cycle . Serial study of fetal biometry at 2 weekly intervals between 22 weeks – 38 weeks was performed to measure fetal kidney parameters and BPD,FL,AC,HC. It showed kidney length predicted GA with better precision than the model with biometric indices of BPD,AC,FL.

Nahid yusuf et al in 2007 did a prospective study in 102 pregnant women after 30 weeks of pregnancy whose GA were confirmed by early USG. The mean length of fetal kidneys showed a linear correlation with GA. The mean fetal kidney length in mm approximates GA in weeks in 3<sup>rd</sup> trimester as predicted by BPD,FL,AC,HC (P<0.001). Maternal height , weight and socioeconomic status did not show any effect on growth of fetal kidneys. The results obtained confirmed that measurement of fetal kidney length can be used as an additional parameter for documentation of GA in 3<sup>rd</sup> trimester and also an early means of detection of abnormal renal development.

In a study by Konje J C et al 2002, they determined whether there are differences in kidney size and shape in small and appropriate for gestational age fetuses at different gestation. The kidney lengths at different GA were similar in the groups. The fetal kidney length at different GA does not alter even in small for GA fetuses.

LampI et al in 2002, did fetal USG measurements to investigate the relationship between weight and ponderal index at birth and kidney size during the second (23 weeks) and third (32 weeks). In a sample of 25 normally growing fetuses, kidney volume, fetal weight at 32 weeks were significantly and positively related to both weight and ponderal index at birth, controlling for sex, gestational age at birth and day of ultrasound measurement.

Conclusion: Fetuses relatively thin at birth have relatively smaller kidneys for their size in late gestation which suggests that the influence of maternal weight on birth outcome may act through organ growth.

Callen's USG in obstetrics and gynaecology states standard measurement for renal circumference, volume, thickness width and length

as a function of menstrual age. Renal length and AP diameter corresponds to menstrual age in weeks and twice AP diameter in millimeter respectively.

Cohen hl et al has given a table showing mean renal length for various gestational age after a sonographic study in 397 obstetrics patients – American journal of radiology.

Glove JM et al in 1997 analysed 100 pregnant women and found fetal body weight, renal length, renal volume increased throughout gestation and fetal kidney length corresponds to gestational age of fetus.

Scott et al in 1995, measured the external and internal dimension of fetal kidney. In 810 women external renal dimension and GA were closely related enabling accurate growth centile chart to be constructed.

Hunter et al 1990, measured the renal size in 560 patients on 3 dependent variables kidney length, depth, area together with 3 independent variables birth weight, HC, GA. He showed significant difference between right and left kidney in length and depth for each

independent variable. Kidney depth and area in boys were larger than in girls.

Pruggmayer et al 1989 did a cross sectional study of 612 fetuses he found that the fetal kidney length correlated with GA except for growth retarded and macrosomic fetus from diabetic mother.

Saji et al in 1987 assessed the fetal kidneys in 660 normal fetus and found a linear correlation with GA.

Inseua et al 1986 studied the changes in size of fetal kidneys with advancing gestational ages.

Gonzales et al in 1980, studied 390 patients. They concluded that size and weight of kidney increase with increase in duration of pregnancy.

Grannum p et al in 1980 analysed 89 patients not at risk for kidney disease. The study was done from 12 weeks till term and found kidney length increases linearly till term.

## **AIMS OF THE STUDY**

1. To obtain the measurement of foetal kidney length in the patients enrolled in the study.
2. To evaluate the application and accuracy of foetal kidney length measurement in determining the gestational age of the foetus in 3rd trimester in patients with known and unknown dates.
3. To compare its accuracy with that of other selective foetal biometric indices (BPD, FL, AC).

## **MATERIALS AND METHODS**

The study was carried out in the department of OBG at RSRM lying in Hospital, Chennai from period of dec09 – October 10.

150 singleton pregnant women in third trimester without any complications were chosen for the study.

Informed consent for my study was obtained, ethical committee clearance was obtained.

### **Study Design – Prospective study**

#### **Inclusion criteria**

- ▶ Primi / Multiparous women with known dates / unknown dates of last menstrual period.
- ▶ Singleton Pregnancy.

#### **Exclusion criteria**

- ▶ Gross maternal obesity.
- ▶ Medical complications – Diabetes / Hypertension.
- ▶ Obstetric complications –oligo/ Polyhydramnios.
- ▶ Fetal anomalies, IUGR, Multiple pregnancies.

## **Examination method**

A thorough history regarding the regularity of cycles, earliest scan, urine pregnancy test, earliest estimation of uterine size, date of quickening was obtained to confirm the gestational age.

The registered women were subjected to routine antenatal examination along with sonographic evaluation. The antenatal examination included weight, height of the patient, blood pressure, systemic and obstetric examination. Symphysiofundal height was measured after emptying the bladder by palpation and gestational age was clinically assessed. Consent for doing USG was obtained.

Routine USG was done in all cases enrolled in the study transabdominally with a real time USG and biometric indices like BPD,FL,AC measured. External renal diameter of right and left kidney was measured and gestational age was assessed clinically and by USG. The patients were followed until delivery.

**In Group 1** – Patients with known dates, gestational age was assessed by clinical data and compared with gestational age by kidney length measurement.

**In Group 2** – Patients with unknown dates, gestational age was assessed by clinical information like uterine size, earliest scan, date of quickening and after birth the maturity of fetus and compared with gestational age by kidney length measurement and accuracy assessed.

## **RESULTS AND ANALYSIS**

In our study 150 women in the 3<sup>rd</sup> trimester were included and antenatal USG was taken for kidney length and other biometric indices and labour outcome of those women were followed. The results were analyzed with respect to the age of the patients, parity, right and left kidney , mode of delivery.



**Table 1: Age distribution**

<b>Age of patients (in yrs)</b>	<b>No of cases</b>	<b>Study group in %</b>
$\leq 19$	11	7.3%
20 – 29	123	82%
30 – 34	12	8%
$\geq 35$	4	2.7%

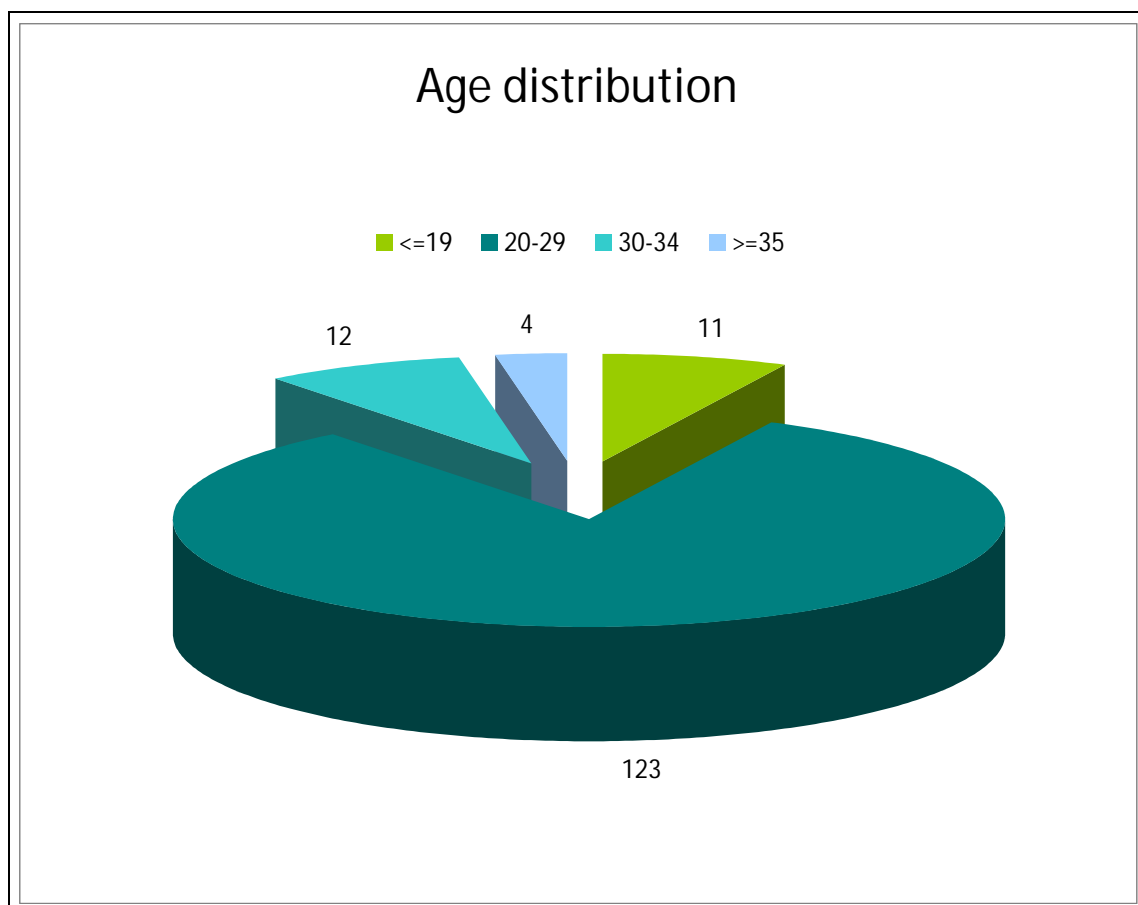
This table shows the age distribution of patients in this study.

- 82% of women were between 20-29 years of age.
- Only 2.7% were above 35 years.
- 7.3% of women belonged to the teenage group.

This study showed that the age of antenatal women showed no significant bearing in the assessment of renal length and its correlation to gestational age.

## Maternal age of study group

**Diagram 1:**



**Table 2: parity distribution**

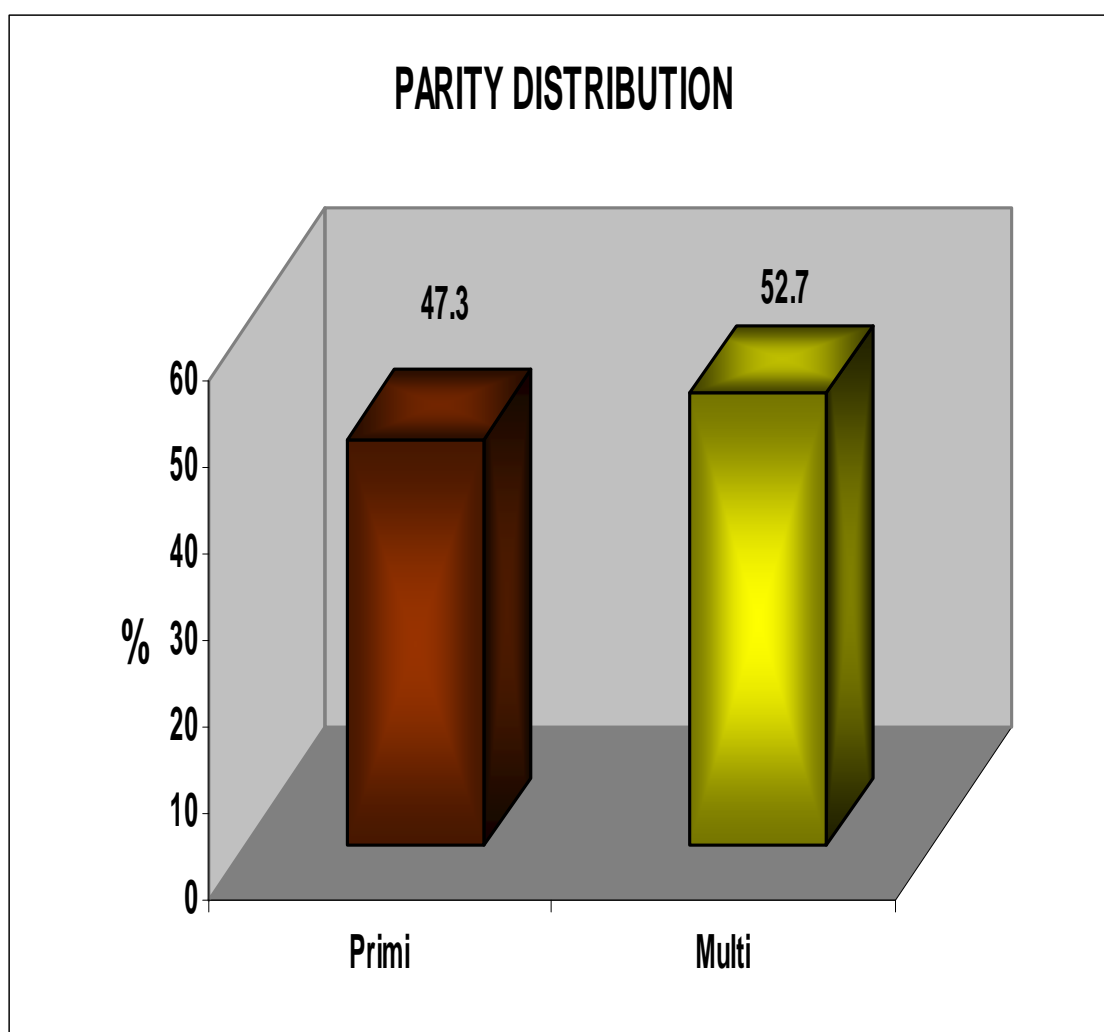
Parity	No of cases	Study group in %
Primi	71	47.3%
Multi	79	52.7%

This table shows the parity distribution of the study group

- 52.7% were multiparous.
- 47.3% were primi.

Our study shows that parity did not alter the kidney length of fetus belonging to the same gestational age.

**Diagram 2:**



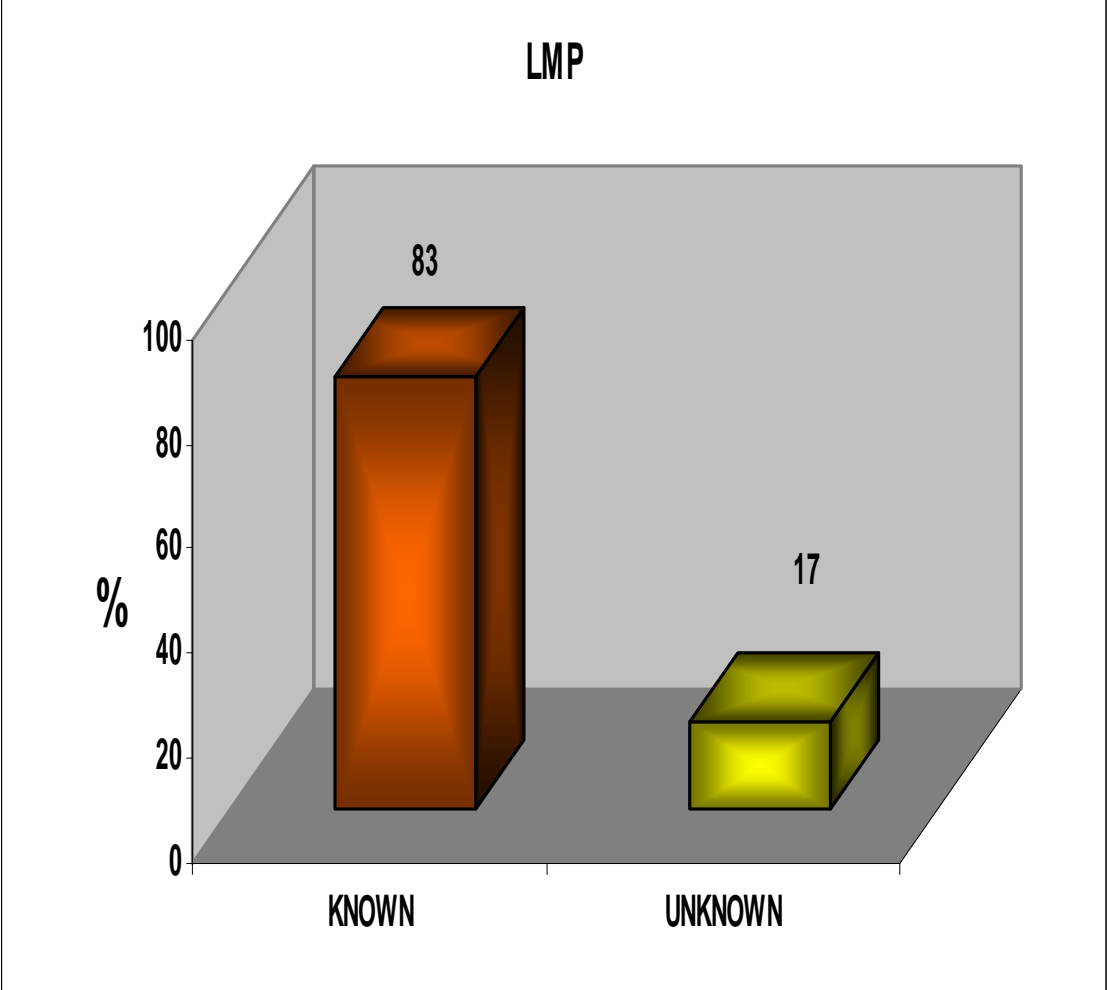
**Table 3 :**

LMP	No of cases	Study group in %
Known	125	83%
Unknown	25	17%

- 83% of antenatal women were sure of their last menstrual period.
- 17% of women did not know their last menstrual period.

Those with unknown dates gestational age was assessed by clinical information like uterine size, earliest scan, date of quickening and other measurements like symphisiofundal height ( Mcdonald's rule), abdominal girth measurement and after birth by the maturity of fetus which was assessed clinically.

**Diagram 3:**



**Table 4: DISTRIBUTION OF NO. OF CASES IN EACH GA**

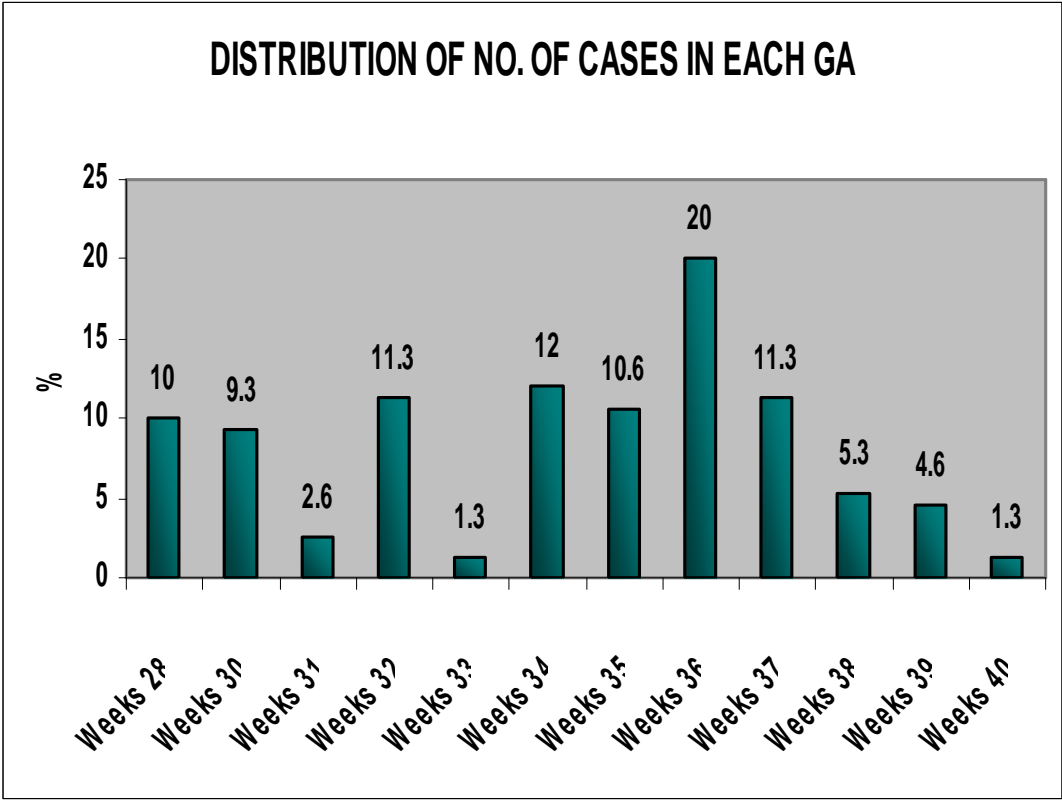
<b>GESTATIONAL AGE(WEEKS)</b>	<b>NUMBER OF CASES</b>	<b>PERCENTAGE OF THE STUDY GROUP(%)</b>
28	15	10
30	14	9.3
31	4	2.6
32	17	11.3
33	2	1.3
34	18	12
35	16	10.6
36	30	20
37	17	11.3
38	8	5.3
39	7	4.6
40	2	1.3

This table (table 4) shows that

- 20% of women belonged to 36 weeks of gestation.
- 1.3% of women belonged to 40 and 33 weeks of gestation.
- 10% of women belonged to 28 weeks of gestation.

This distribution of number of cases in each gestational age was chosen randomly.

**Diagram No.4.**



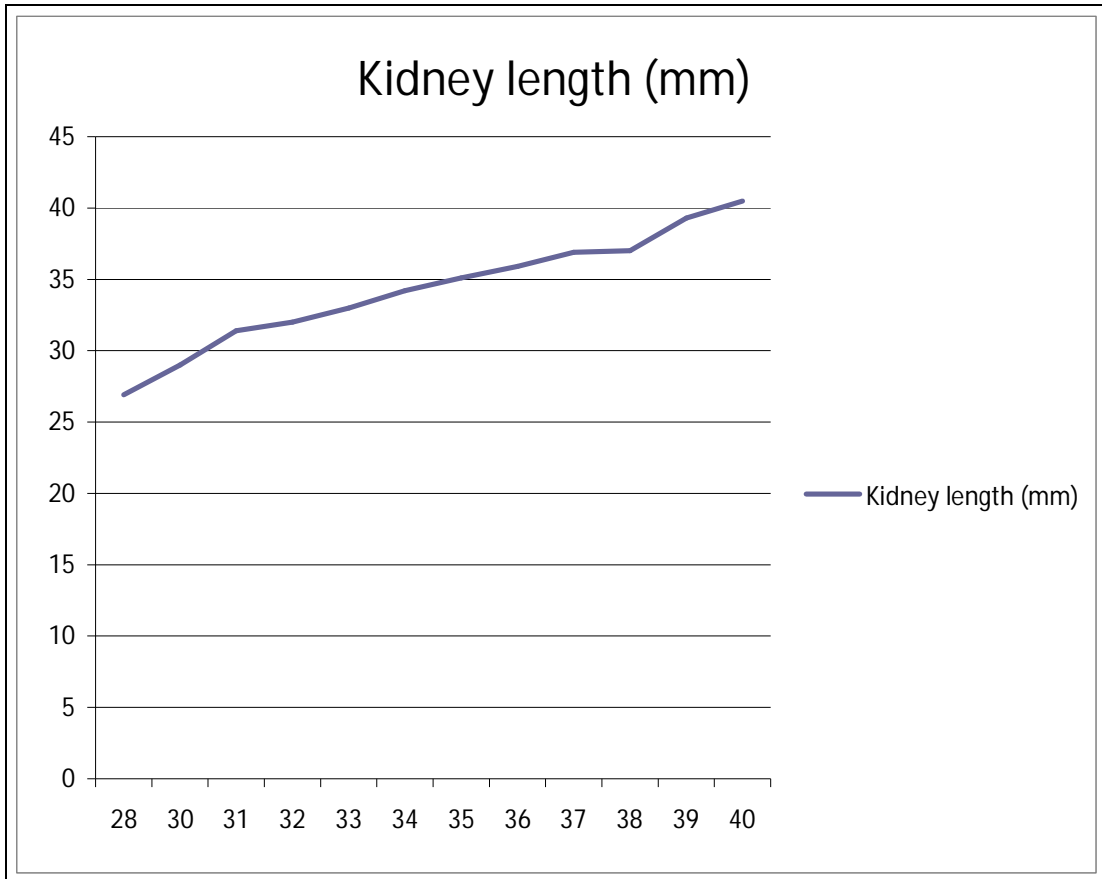


**Table 5: CHANGES IN FOETAL KIDNEY LENGTH WITH GA IN THE STUDY**

<b>GESTATIONAL AGE(WEEKS)</b>	<b>MEAN KIDNEY LENGTH(mm)</b>
28	26.9
30	29.0
31	31.4
32	32.0
33	33.0
34	34.2
35	35.1
36	35.9
37	36.9
38	37.0
39	39.3
40	40.5

“Rule of thumb” - Kidney length in mm approximates gestational age in weeks. This table (table 5) shows the kidney length in mm for each gestational age in this study.

**Diagram 5:**

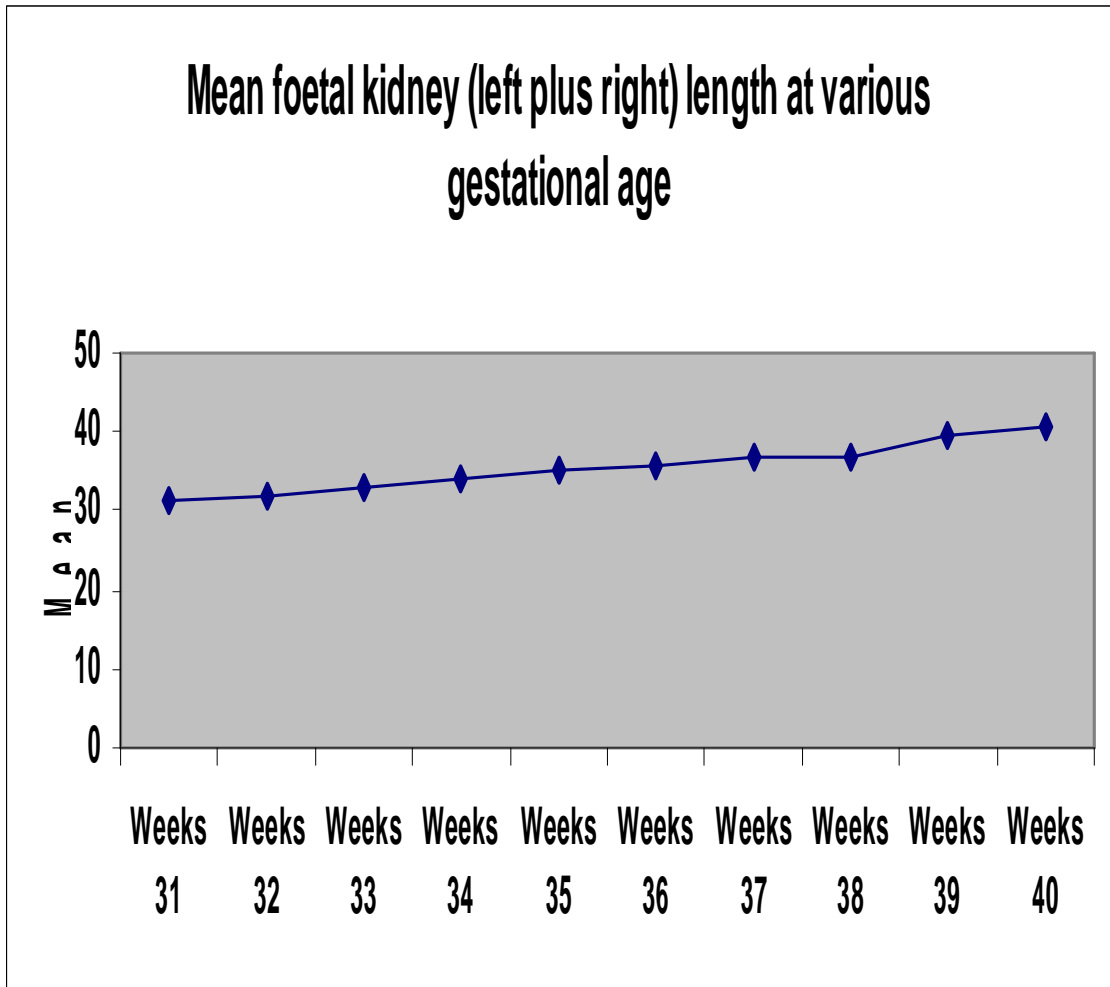


**Table 6: Mean foetal kidney (left plus right) length at various gestational age.**

<b>Gestational age(weeks)</b>	<b>Left kidney</b>	<b>Right kidney</b>	<b>Left plus right(mean kidney length(mm))</b>	<b>Left plus right(mean kidney length(mm))</b>
	<b>In mm</b>	<b>In mm</b>	<b>Mean</b>	<b>Confidence interval(95%)</b>
31	31.2	31.6	31.4	29.2-33.7
32	31	33	32	31.7-32.2
33	33	33	33	29.5-36.5
34	34.1	34.3	34.2	33.9-34.5
35	35.1	35.1	35.1	34.6-35.6
36	36.1	35.7	35.9	35.7-36.1
37	36.5	37.3	36.9	36.6-37.2
38	37	37	37	36.2-37.9
39	39.3	39.3	39.3	38.4-40.1
40	39.8	41.2	40.5	39.2-41.9

Both kidneys right and left were measured. It showed that the right and left kidney size are almost same and average kidney size also showed same gestational age. Mean kidney length increased linearly with increase in gestational age.

**Diagram 6:**



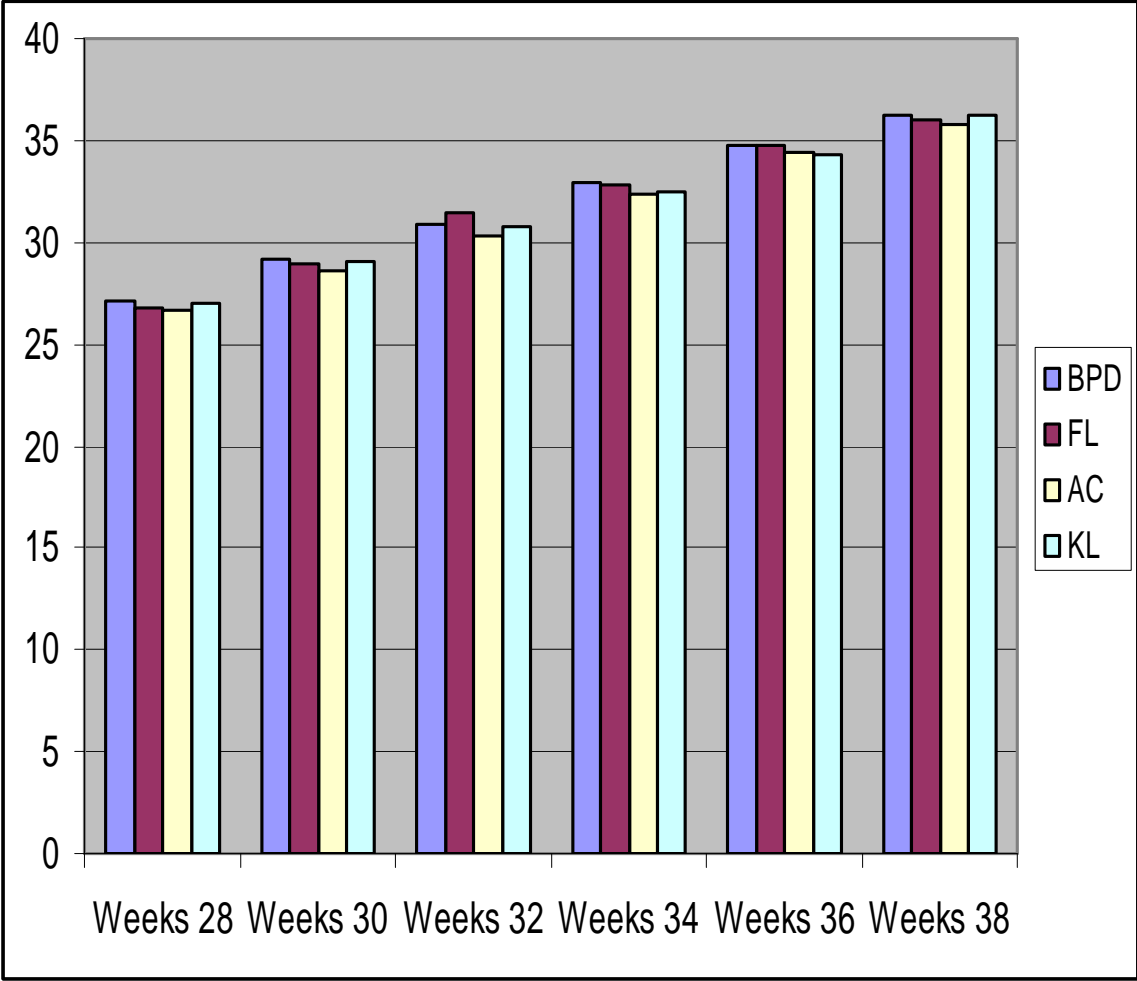
**Table 7: Association between gestational age and BPD, FL, AC, KL  
in the study group**

Gestational age (weeks)	Mean BPD (in weeks) (x±SD)	Mean FL (in weeks)(x±SD)	Mean AC (in weeks)(x±SD)	Mean KL (in weeks)(x±SD)
28	27.08±1.40	26.80±1.22	26.65±1.36	26.98±1.06
30	29.14±1.31	28.90±1.18	28.63±1.45	29.03±1.32
32	30.89±1.44	31.47±1.70	30.31±1.99	30.80±1.53
34	32.96±1.39	32.85±1.10	32.38±1.56	32.51±1.38
36	34.71±1.36	34.77±1.29	34.40±1.47	34.26±1.41
38	36.25±1.17	35.97±0.83	35.81±1.33	36.25±1.70

- This table shows the mean BPD, FL, AC, KL in the antenatal women of each gestational age.
- This table shows that KL correlates well with FL, BPD, and AC in the estimation of gestational age.

**Diagram 7: Association between gestational age and BPD, FL, AC,**

**KL in the study group**



**Table 8: linear regression equation: of various indices i.e.**

**KL/FL/AC/BPD in relation to gestational age.**

<b>parameter</b>	<b>Intercept Estimate</b>	<b>SE</b>	<b>Slope Estimate</b>	<b>SE</b>	<b>P Value</b>	<b>r<sup>2</sup></b>	<b>SEp</b>
KL	2.964	0.42	0.832	0.014	<.001	97.6	9.17
FL	0.741	0.52	0.411	0.006	<.001	94.8	10.2
AC	3.898	0.87	0.84	0.003	<.001	92.4	11.1
BPD	3.084	0.42	0.39	0.004	<.001	90.9	10.9

This table shows the equations derived from linear regression analysis when the individual variables were considered separately.

The most accurate was KL with standard error of 9.17 days, while the most inaccurate was AC with standard error of 11.1 days.

BPD in this study dates pregnancy with standard error of 10.9 and FL dates pregnancy with standard error of 10.2 days.

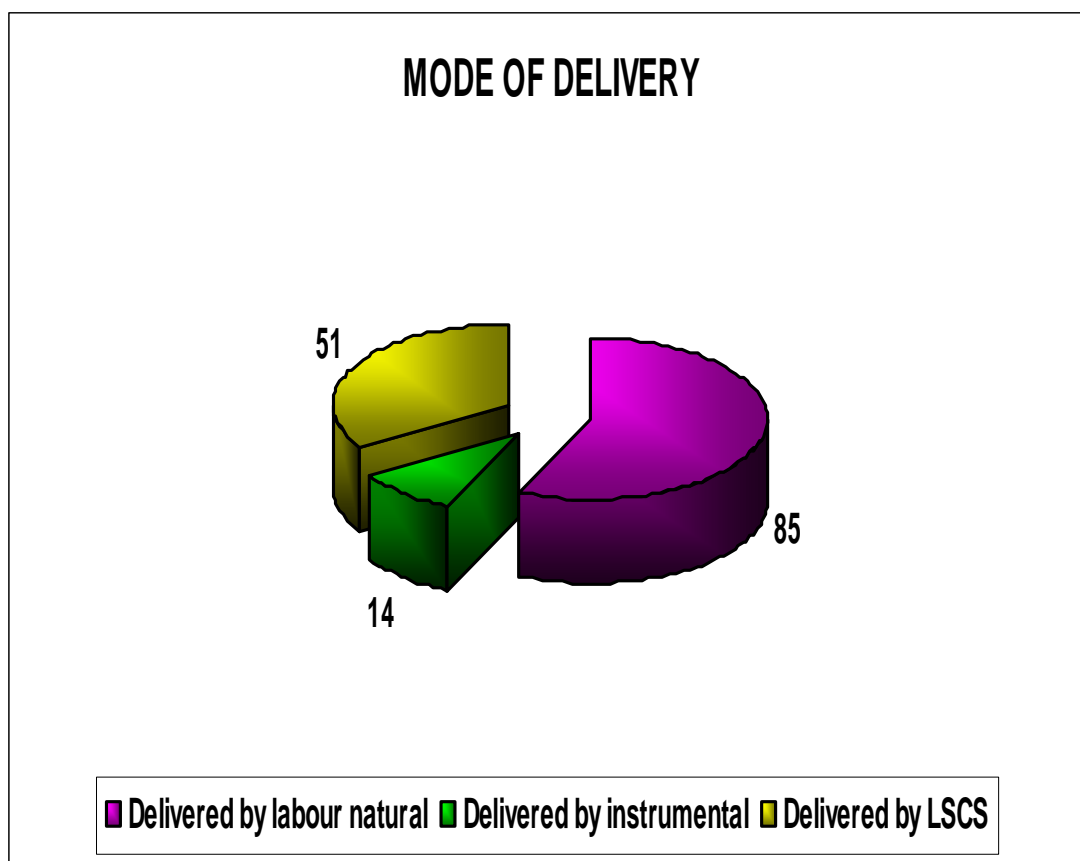
**Table 9: Distribution of mode of delivery**

<b>Mode of delivery</b>	<b>No of cases</b>	<b>% of study group</b>
Delivered by labour natural	85	57
Delivered by instrumental	14	9
Delivered by LSCS	51	34

- The antenatal women in this study were followed till delivery and the maturity of fetus was confirmed after birth of the baby.
- This table shows the mode of delivery of the study group which is not related to kidney size.
- 56% of women delivered by labour natural.



**Diagram 9:**

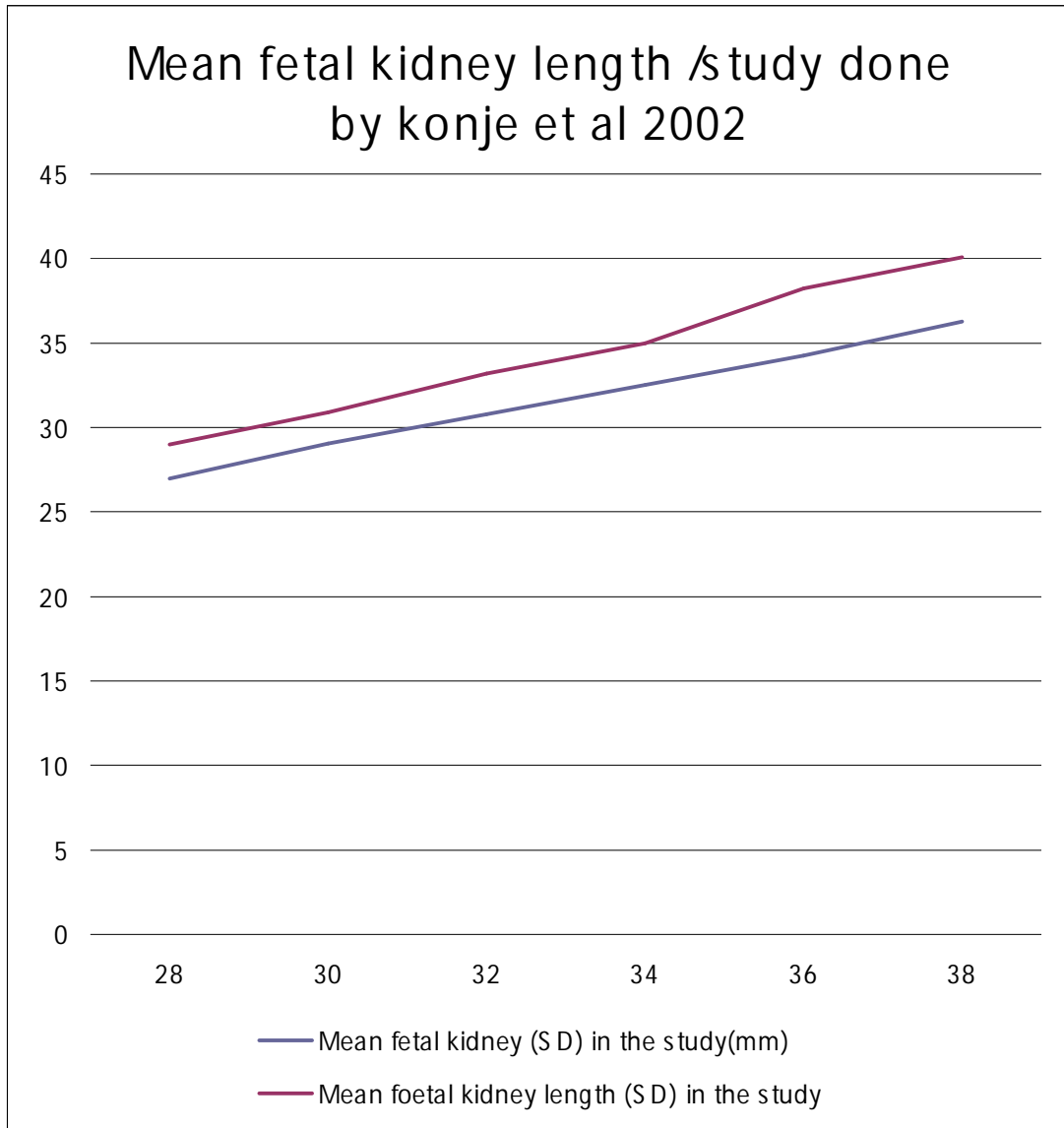


**Table 10: comparison between the mean fetal kidney length of the study with that of the study done by konje et al 2002**

<b>Gestational(in weeks)</b>	<b>Mean fetal kidney (SD) in the study(mm)</b>	<b>Mean foetal kidney length (SD) in the study by konje et al</b>
28	26.98(1.06)	29.0(2.2)
30	29.03(1.32)	30.9(3.2)
32	30.80(1.53)	33.2(4.5)
34	32.51(1.38)	35(3.6)
36	34.26(1.41)	38.2(4.2)
38	36.25(1.70)	40.1(2.4)

- This table shows the comparison between the mean fetal kidney length of the present study with that of the study by konje et al 2002.
- The values for fetal kidney length at different gestational ages was lower than the study by konje et al.

**Diagram 10:**

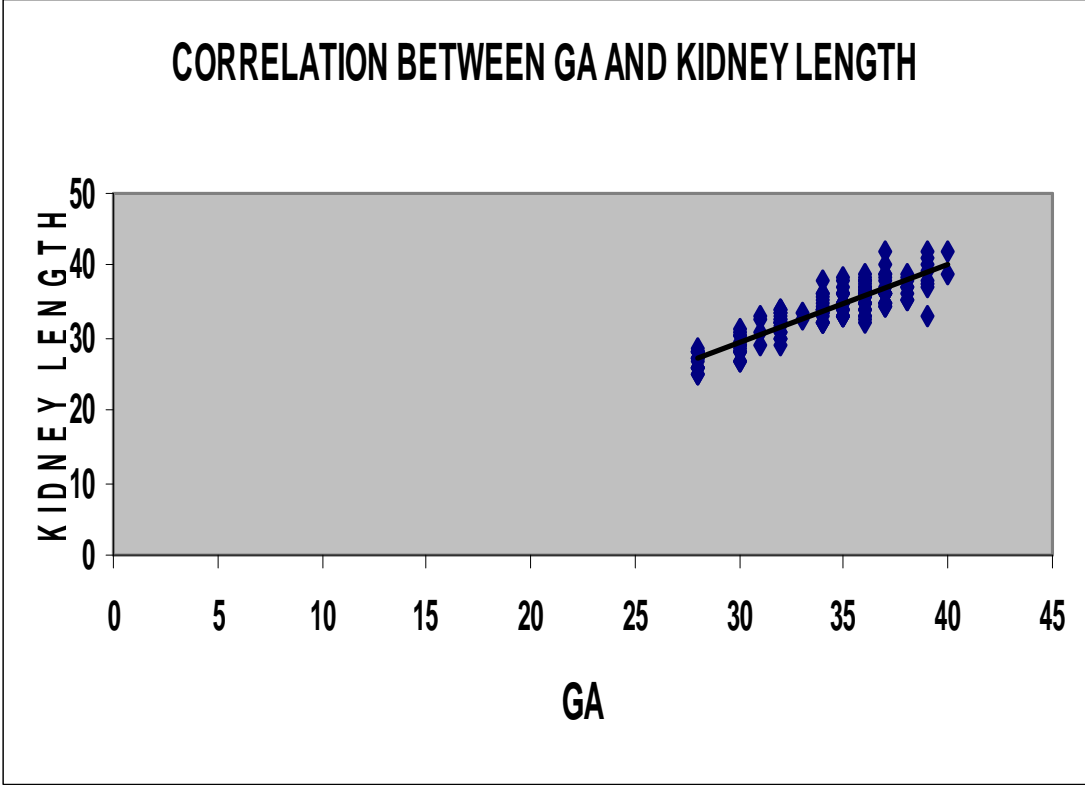


**Table 11: linear regression equation: comparison between the present study and the study by konje et al 2002**

Parameter s	study	Intercept estimate	Intercept SE	Slope estimate	Slope SE	P value	r <sup>2</sup>	SEp
KL	present	2.964	0.42	0.832	0.014	<.001	97.67	9.17
	Konje et al	3.821	0.38	0.858	0.12	<.001	90	10.2
FL	present	3.084	0.52	0.411	.006	<.001	94.84	10.2
	Konje et al	5.0	0.34	0.449	.005	<.001	89	10.9
AC	present	3.898	0.87	0.84	.003	<.001	92.4	11.1
	Konje et al	5.493	0.45	0.97	.002	<.001	81	14.5
BPD	present	0.741	0.42	0.39	.004	<.001	90.9	10.9
	Konje et al	0.808	0.44	0.38	.005	<.001	88	11.6

- This table shows the comparison of different biometric indices of the present study and study by konje et al.
- KL in the present study dates pregnancy within  $\pm$  9.17 days.
- In konje et al study, KL dates pregnancy with an accuracy of  $\pm$  10.2 days.
- AC is the worst predictor, KL is the best predictor in comparison with other biometric indices for estimation of gestational age.

**Diagram 11:**



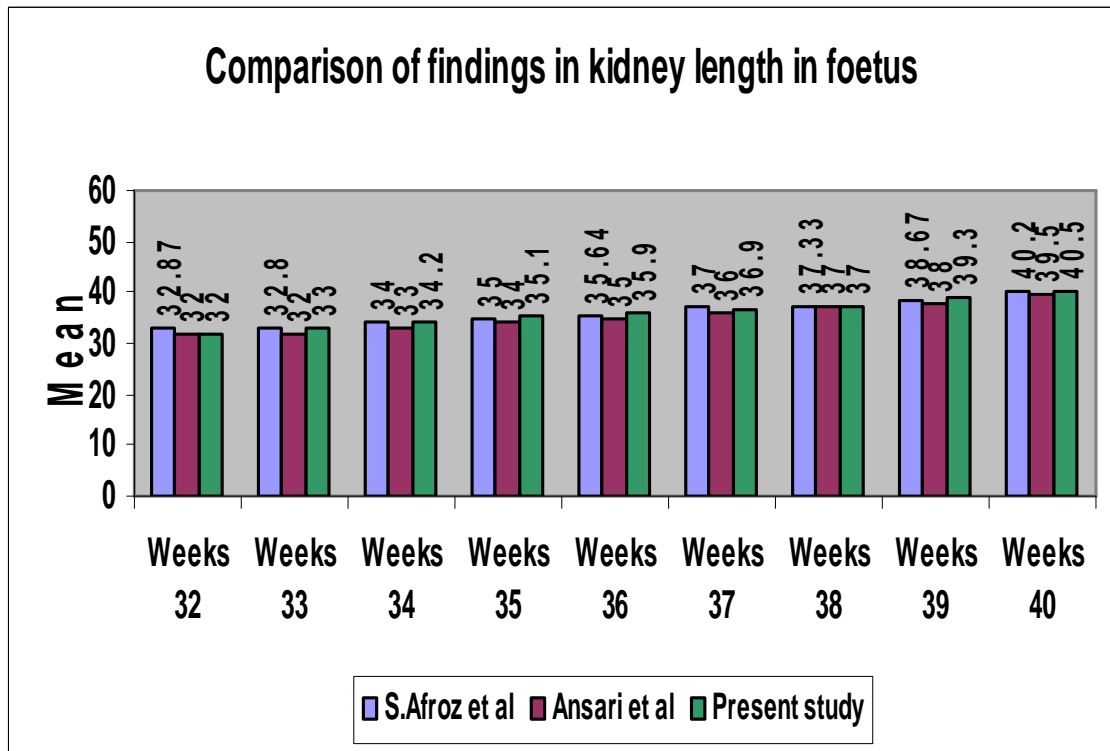
Scatter plot showing the correlation between gestational age and kidney length.

**Table 12: Comparison of findings in kidney length of foetus of the present study with other studies**

<b>Gestational age (weeks)</b>	<b>S.Afroz et al</b>	<b>Ansari et al</b>	<b>Kidney length (mm) Present study</b>
31	30.00	32.0	31.4
32	32.87	32.0	32.0
33	32.80	32.0	33.0
34	34.00	33.0	34.2
35	35.00	34.0	35.1
36	35.64	35.0	35.9
37	37.00	36.0	36.9
38	37.33	37.0	37.0
39	38.67	38.0	39.3
40	40.20	39.5	40.5

The kidney length of the present study were compared with studies by Ansari et al and Afros et al and it showed a close correlation with these two studies.

Diagram 12:



In this study, we have analyzed 150 patients not at risk for fetal kidney disease and whose pregnancies resulted in a normal fetal outcome, to determine how renal length varies with gestational age. The study group included women in the third trimester from 28 weeks to term.

The results were analyzed with respect to age of the patient, parity, right and left kidney and compared with other biometric indices. In this study 82% of women were between 20-29 years of age, 7.3% belong to the teenage group and only 2.7 were above 35. Parity distribution was almost equal. 83% of women had known LMP. 20% of women in the third trimester belonged to 36 weeks of gestation. The present study has shown that the age, parity, right and left kidney shows no significant bearing in the assessment of renal length and its correlation with gestational age. This study shows that kidney length increases linearly with gestational age. It dates pregnancy with the accuracy of  $\pm 9.17$  days. KL was compared with other biometric indices like BPD, FL, AC. BPD dates pregnancy with the accuracy of  $\pm 10.9$  days, FL by  $\pm 10.2$  days, AC by  $\pm 11.1$  days, suggesting that AC is the worst predictor and KL is the best predictor in the estimation of gestational age. Hence, this study has concluded that kidney length can be combined with other biometric indices to increase the accuracy in estimation of gestational age.



## **DISCUSSION**

There are several studies which were done earlier in other countries like UK, USA,GERMANY. There are only a few Indian studies to show the relation between Gestational Age and Renal length. So this study is done to find out whether there exists any differences among different women of different ethnic groups.

Sato et al in his study in 1997, showed that kidney growth correlates well with abdominal circumference and could be an additional parameter for the detection of intrauterine growth retardation, but since we have excluded antenatal women with risk factors, this study was not able to show whether, it can be used as a predictor of intrauterine growth retardation. Likewise, since we did not include diabetic mothers, our study cannot say whether renal length correlates with gestational age in macrosomic foetus.

Our study shows that the age, parity, sides of kidney show no significant bearing in the assessment of renal length and its correlation to gestational age.

The study demonstrated that by measuring kidney length, pregnancies could be dated within  $\pm 9.17$  days in those booking late or in those who had forgotten their last menstrual period and presented late for booking which is in correlation with the study by JJ Kansaria et al 2009. Kidney length predicted gestational age with better precision than the model with biometric indices of abdominal circumference and femur length, this provides an obvious advantages where biparietal diameter and/or head circumference cannot be accurately measured because foetal head is too low or correct plane for measurement cannot be obtained. In these circumstances, therefore kidney length can be used on its own to estimate gestational age.

The linear equations derived from present study have been compared with the individual variable separately with the study done by Konje et al 2002.

The most accurate was the foetal kidney length with a standard error (SE) of 10.29 days by Konje et al and 9.17 days by this study; while the most inaccurate was abdominal circumference with a standard error of 14.54 days by Konje et al and 11.14 days by this study.

In our study the values of fetal kidney length at different gestational ages was lower than the study by Cohen et al 1991, Konje et al, and Lawson et al 1981 but similar to those reported by Bertagnoli et al 1983 and Jeanty et al 1982.

Although fetal kidney size, as for all fetal organ is affected by growth variations these appear to predominately affect only the AP and transverse diameter but not the kidney length.

Rule of thumb is that “renal length in mm approximates GA in weeks”. In our study we also found that the mean length of fetal kidney linearly increased with gestational age and a strong correlation exists between fetal kidney length and GA determined by BPD, FL, AC and an average of these which is similar to the study by konje et al 2002. However it should always be remembered that a single USG examination for determining gestational age is unreliable after 30 weeks, so taken in conjunction with BPD, FL, AC, renal length could well be used as an additional parameter for determination of gestational age and also an early means of detection of abnormal renal development.

## SUMMARY

In this study we have analyzed 150 antenatal women with no obstetrics / medical risk factors and estimated their fetal kidney length and found a linear correlation with gestational age.

The study group was analyzed and distributed according to age, parity, known / unknown LMP.

- 82% of the study group were between 20-29yrs of age.
- 53% were multiparous.
- 83% of the study group were sure of dates.

The patients were followed till delivery and the gestational age was assessed after birth by the maturity of fetus and compared with GA by kidney length.

Both kidneys right and left were measured . It showed that the right and left kidney length were almost the for the same gestational age .

Our study shows that the age, parity, sides of kidney show no significant bearing in the assessment of renal length and its correlation to gestational age.

This study has dated pregnancy within  $\pm 9.17$  days by measuring kidney length. Kidney length predicted GA with better precision than other biometric indices.

So taken in conjunction with BPD, FC, AC renal length can be used as an additional parameter to date pregnancy accurately in 3<sup>rd</sup> trimester.

## CONCLUSION

Diagnostic USG is a non-invasive, safe and useful investigative method to clear the different dilemmas in obstetrics, particularly it is very much helpful in estimating the gestational age of the fetus. It is relatively simple, easy to perform and can be repeated and has shown to be free from risk to the mother and fetus.

Fetal kidney length fulfills the need of the hour, it is an investigational tool that will accurately predict the estimated date of confinement without being affected by the discrepancy of late trimester or by growth retardation of fetus. In India where routine early antenatal registration is not a very common phenomenon, particularly in the rural area and where illiteracy makes it difficult to elicit proper menstrual history, it is very imperative that accurate dating is available. Fetal kidney is easy to identify and to reproduce.

In our study patients with known and unknown dates of LMP were taken and their kidney measurements were recorded and gestational age assessed prenatally the maturities of the fetus were confirmed after birth.

Our study shows that the age, parity, sex of the infant, sides of kidney shows no significant bearing in the assessment of renal length and its correlation to gestational age.

In our study it has shown that fetal kidney length dates pregnancy within  $\pm 9.17$  days unlike other biometry which dates pregnancy within  $\pm 15$  to 21 days.

Still more studies are required to determine the accuracy of correlation between renal length and other biometric indices.

## **PROFORMA**

NAME :                      AGE:                      OP NO.:

SOCIO ECONOMIC CLASS:

PARITY :

LMP:    EDD :

MENSTRUAL HISTORY :

OBSTETRIC HISTORY :

MEDICAL DISORDER/COMPLICATIONS

DATE OF QUICKENING :

O/E – HT:                                      WT:                                      B.P:

SYMPHYSIOFUNDAL HEIGHT:

ABDOMINAL GIRTH MEASUREMENT:

URINE PREGNANCY TEST:

EARLY SCANS:

INVESTIGATIONS:

HB:

URINE – ALBUMIN:                                      SUGAR:

BLOOD GROUP, RH TYPING:

BLOOD SUGAR:

USG DONE ON:



## **ABBREVIATION**

GA – Gestational Age

HC – Head Circumference

FL – Femur Length

AC – Abdominal Circumference

BPD – Biparietal Diameter

KL - Kidney Length

USG - Ultrasonography

SCE - Sister Chromatid Exchange

IUGR - Intrauterine Growth Retardation

LMP – Last Menstrual Period

EDD – Expected Date of Delivery

OCP – Oral Contraceptive Pill

C - Caesarean section

L – Labour natural

I – Instrumental delivery

DETAILS OF USG:

NO OF FOETUS:

PRESENTATION:

BPD:

FL:

AC:

FETAL KIDNEY LENGTH:

PLACENTA:

LIQUOR:

IMPRESION:

POSTNATAL DETAILS:

DATE OF DELIVERY:

SEX OF THE BABY:

BIRTH WEIGHT:

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## MASTER CHART

SL NO.	OP NO.	PARITY	GA	KIDNEY LENGTH	MODE OF DELIVERY	SEX	G 1 / 2 / 3	RIGHT/LEFT
1	30384	P	34	34.4	C	M	2	L
2	26964	P	30	27	I	F	3	R
3	13785	P	39	39.4	L	M	2	L
4	1618	M	30	31	C	M	1	R
5	26020	M	37	38.4	L	M	2	L
6	18178	M	28	25.1	C	M	2	L
7	19006	P	36	38	C	F	3	R
8	8913	M	32	31	L	F	2	R
9	27029	P	30	28	L	M	1	L
10	26997	P	34	35.6	C	F	2	R
11	22161	M	28	28	L	M	3	R
12	26968	P	39	42	C	F	2	L
13	25274	M	34	36.2	L	F	1	R
14	18072	P	32	31.8	C	M	2	L
15	27023	M	36	36.5	L	F	3	R
16	12519	P	30	27	L	M	2	R
17	26502	M	32	30	L	M	3	L
18	13719	M	34	34	C	F	2	R
19	12796	M	28	26	L	M	2	R
20	5350	P	39	41	I	F	1	L
21	13298	P	32	30.1	L	F	2	L
22	23907	P	35	38.2	C	M	2	R
23	27428	M	30	29	L	M	2	R
24	13686	M	36	34	L	F	2	L
25	26554	P	28	27.3	C	M	2	R
26	26225	P	37	34.3	I	F	1	L
27	25263	M	33	32.4	L	F	2	R
28	13681	P	36	35	L	F	2	L
29	25254	P	39	40	C	M	3	R
30	5405	M	36	36	L	M	2	R
31	25743	P	30	30.2	C	M	2	L
32	26606	M	36	36	L	M	2	L

33	15237	P	28	28.2	C	F	1	R
34	14316	P	35	35	L	F	2	L
35	22944	P	36	37	C	M	2	L
36	25917	M	30	29.4	L	F	2	L
37	2043	M	34	34.1	L	F	2	R
38	26562	P	32	32.4	C	M	3	R
39	1551	P	37	35	L	F	1	L
40	26919	P	28	26.1	L	F	2	R
41	26502	M	35	34	L	F	2	L
42	2043	M	39	38	C	M	2	R
43	24619	P	34	32	C	M	3	L
44	26558	M	37	36	L	F	2	R
45	22330	P	30	28.4	C	F	2	R
46	5539	M	37	40.1	L	M	1	L
47	1573	P	35	33	C	M	2	R
48	9849	P	28	27.1	L	M	2	L
49	22998	P	37	39	L	F	2	L
50	22976	M	34	33.1	L	F	3	R
51	2290	P	32	32	C	M	2	L
52	21669	P	36	36.5	C	M	2	L
53	12193	M	35	36	L	F	2	R
54	5562	M	34	32	C	M	2	R
55	11643	M	30	29.2	L	F	1	R
56	21690	P	32	32.6	I	M	1	R
57	22310	M	35	35	L	M	2	L
58	21131	P	31	31	C	M	2	R
59	11557	M	38	36	L	M	1	L
60	23031	M	32	34	L	F	2	L
61	2275	P	37	37	C	F	2	R
62	22412	P	28	28	C	F	3	L
63	10539	P	36	35	C	M	2	R
64	3056	M	39	33	L	M	2	L
65	1922	M	30	28.3	L	F	1	L
66	18114	M	36	36.3	L	F	2	L

67	20818	P	39	37.7	L	M	2	R
68	18722	P	32	32	C	M	1	L
69	22585	M	36	37	L	F	2	L
70	19683	M	35	36.2	L	F	2	R
71	24307	P	38	35.1	I	M	2	L
72	19802	M	28	27.1	L	M	1	R
73	597	P	36	38	L	M	2	L
74	23908	M	37	41.9	L	M	2	L
75	19391	P	34	34	C	F	2	R
76	20812	M	36	34	L	F	3	R
77	9544630	M	33	33.6	C	M	2	L
78	2662	M	35	37.9	L	M	2	R
79	25532	P	39	37	L	M	2	L
80	27218	P	38	37	L	M	1	R
81	26368	P	34	36	I	F	2	L
82	17717	M	30	29.1	L	M	2	R
83	27226	M	38	37.2	C	M	3	L
84	27214	M	37	36.1	L	F	2	R
85	26223	M	32	29	C	F	2	L
86	6783	P	35	37	L	M	2	L
87	7284	M	38	35.1	C	M	2	R
88	27223	M	34	35.4	L	F	1	R
89	26517	P	32	34.1	I	F	2	R
90	25746	M	37	36	L	F	2	L
91	12517	M	30	30.2	L	F	2	L
92	12162	M	35	36	C	M	3	R
93	12909	M	34	33.6	L	F	2	R
94	15278	P	36	32.6	I	F	2	L
95	9805	M	37	35	L	F	2	R
96	12160	P	32	33.6	C	M	2	L
97	14110	M	35	35	L	F	2	R
98	7255	M	32	33.4	L	F	2	R
99	12169	P	34	32.1	I	F	1	R
100	19963	M	31	29.1	C	F	3	R



101	4086	P	37	36.2	L	F	2	R
102	9435	M	28	26	L	F	1	R
103	14336	P	36	35	C	F	2	R
104	16877	M	32	31	L	F	2	L
105	22206	P	34	33.4	L	M	2	R
106	22205	P	36	35	C	F	3	L
107	22149	P	28	25	L	F	2	R
108	26599	M	35	33	C	F	2	L
109	5665	M	32	32	C	M	2	R
110	1573	P	36	33	I	F	1	L
111	3021	P	28	26	L	F	2	R
112	3682	M	36	36.9	L	M	2	L
113	12974	M	34	34	C	F	2	R
114	19212	P	36	36.2	L	M	3	L
115	27300	P	28	27	L	M	2	R
116	5405	P	36	32	L	M	2	R
117	27284	P	37	34.5	L	F	1	L
118	1900	M	40	39	I	F	2	L
119	27308	M	28	28	C	M	2	R
120	9562	M	34	34.9	C	F	2	R
121	12306	P	32	32	L	M	2	R
122	8938	M	36	38	L	M	1	R
123	27607	P	35	33.2	L	F	2	L
124	24155	M	30	31.2	C	F	2	R
125	13144	M	36	37.4	I	M	2	L
126	27421	P	38	38	L	F	2	L
127	27361	P	36	36	L	F	3	R
128	13931	M	37	36	L	F	2	L
129	24912	P	31	32.4	I	M	1	R
130	12114	P	36	35.6	L	F	2	L
131	27721	M	36	33	C	F	2	L
132	12932	M	37	35	L	M	2	R
133	10311	M	28	28.6	C	F	2	L
134	27377	P	36	36	L	F	1	R

135	14408	M	40	42	L	F	2	R
136	20681	P	35	34.1	I	M	2	L
137	4437	M	32	33	L	M	2	R
138	19205	M	37	37.8	L	F	3	L
139	7452	M	38	38.6	C	F	2	R
140	16851	P	30	28	L	F	1	L
141	26975	M	36	35.6	C	F	2	R
142	13324	M	35	33	L	M	2	R
143	23233	M	34	37.8	C	M	3	R
144	169	P	36	38	L	F	2	L
145	27560	M	31	33.1	C	F	1	R
146	19006	M	36	39	C	F	2	L
147	25010	P	37	39	I	M	2	R
148	3643	M	36	38.4	L	M	2	L
149	25531	M	35	35	C	M	2	R
150	690	P	38	39	L	M	2	R