Original Research Article

Ultrasonographic assessment of third trimester fetal kidney length as a measure of gestational age in growth restricted fetuses

Abstract

Background: Obstetric ultrasound is the initial imaging method used to evaluate the fetus and monitor growth.Fetal ultrasonography is useful for dating when the last menstrual period (LMP) is uncertain. Studies have shown that about 30% of pregnant women forget the date of their LMPWhen the precise gestational age (GA) is unknown, the outcome of the pregnancy may be unfavorable. To assess the ultrasonographic fetal kidney length as a measure of gestational age in third trimester

Methods: - All participant women were in the third trimester whose gestational age was calculated by reliable LMP which was confirmed by recorded ultrasonic measurement of BPD, AC& FL).

- Participant women were divided into 2 equal groups:

Group 1: normal pregnancy& average

Group 2: patients with growth restriction fetuses.

Results: The mean length and width of the left kidney were similar in both groups, as the mean length of the left kidney in the IUGR group was (38.40 ± 4.000) while it was in the control group (38.17 ± 3.637). The average width of the left kidney in the intrauterine growth restriction group was (23.09 ± 2.339) while it was in the control group (23.16 ± 2.341), there were significant positive correlations between the different study variables. A positive association was found between gestational age, fetal weight, bipolar diameter, femur length and abdominal circumference with the length of the right kidney, and they also found a positive association with the length of the left kidney.

Conclusions: In absence of renal anomalies/ abnormalities, kidney measurements; length, weight, volume can be used to determine gestational age accurately.

No difference between measuring Rt or Lt kidney on determining GA. Also, no difference between measurements in female or male fetuses.

Kidney measurement is not affected in cases of IUGR and can be used as a reliable indicator for actual gestational age of the fetus in these cases.

. Keywords: Ultrasonographic , fetal kidney ,, gestational ,restricted fetuses

Introduction:

Obstetric ultrasound is the initial imaging method used to evaluate the fetus and monitor growth.)1) Fetal ultrasonography is useful for dating when the last menstrual period (LMP) is uncertain.(2) Studies have shown that about 30% of pregnant women forget the date of their LMP.(3, 4)When the precise gestational age (GA) is unknown, the outcome of the pregnancy may be unfavorable.(5,6)Decisions regarding obstetric management and subsequent neonatal outcomes are significantly affected by precise knowledge of GA. Prevention of perinatal mismanagement and scheduling the labor date are also guided by knowledge of GA.(5,7,8) Lack of a precise GA is associated with high perinatal mortality rates, an increased incidence of low birth weight, and spontaneous preterm delivery.(2)

Many biometric parameters such as crown rump length, biparietal diameter (BPD), femoral length (FL), abdominal circumference (AC), and head circumference (HC) are used to date pregnancy. (2,7) When combined, these parameters agree well with GA to some extent. Although they are reliable up to the early second trimester, they are less reliable in the late second and third trimesters,(9) where the error margin becomes wide after 30 gestational weeks.(8) They are also unreliable in late pregnancy in cases of intrauterine retardation.(10)

Some studies have shown a strong correlation between renal length and GA determined by BPD, FL, and AC, or an average of all three.(7,11,12)In addition, Konje et al.(12) reported that fetal kidney diameter and circumference, in addition to kidney length, also give accurate gestational dating. Knowledge of normal renal parameters is essential for

accurate evaluation of abnormal kidneys, because fetal kidney disease is among the most common malformations, (13) and some disorders affect renal size without significantly altering architecture. (14)

With the increased use of ultrasonography in obstetrics, it has been noted that the incidence of renal disease in the prenatal and neonatal period is approximately 10% of all pregnancies. (15) Many abnormalities are minor and have no clinical significance, whereas the frequency of major malformations of the kidney, excluding polycystic kidneys, has been estimated as 4–7 in 1000 fetuses.(15). To assess the ultrasonographic fetal kidney length as a measure of gestational age in third trimester.

Patients and methods:

Prospective observational case control study design was conducted.

2. Study Population

- All participant women were in the third trimester whose gestational age was calculated by reliable LMP which was confirmed by recorded ultrasonic measurement of BPD, AC& FL).
- Participant women were divided into 2 equal groups:

Group 1: normal pregnancy& average

Group 2: patients with growth restriction fetuses.

Inclusion criteria:

Singltone fetus.

living fetus confirmed by first trimester Us.

Normal pregnant women in third trimester of pregnancy.

Growth restricted fetuses.

Gestational age >28 weeks.

Exclusion criteria:

Abnormal fetal renal morphology (nephromegaly, agenesis, hypoplasia, cyst, polycystic kidney, hydronephrosis).

Gross maternal obesity (BMI > 35).

Congenital fetal anomalies.

3. Study Setting

This study was conducted at the outpatient clinic of the department of Obstetrics & Gynecology and radiodiagnosis and imaging department, Tanta University Hospital from the period from February 2020 till the end of study.

Patients recruitment: the pregnant women who agreed and consented to participate in this study were collected from the outpatient clinics, during the period from February 2020 till the end of study.

4. Sample size

Sample size calculated according to the following formula (81)

Where:

n= sample size

$Z\ \alpha/2 = 1.96$ (The critical value that divides the central 95% of the Z distribution from the 5% in the tail)

$Z\beta = 0.84$ (The critical value that separates the lower 20% of the Z distribution from the upper 80%) (82).

σ = the estimate of the standard deviation = 32.22

μ1 = mean of total renal volume in the normal fetuses= 35.90

μ2 = mean of total renal volume in growth-restricted fetuses= 17.75

According to the previous data, the required sample size is 50 participants per group, so the total required sample size was 100 participants.

5. Data collection:

Patients of GA between 28 & 36weeks were subjected to:

1- Informed written consent 2- Detailed history taking

full history taking including (personal, present, past, menstrual, family and obestetric history).

Personal history:

(Name, Age. Height, Weight. Marital Status, Occupation, Address & Special habits of medical importance.) for identification and facilitate communication with the patient.

Past history of medical importance e.g

(allergies, blood transfusion, hospitalization or any other medical conditions).

present history:

To assess general condition in pregnancy and diagnose any abnormality.

family history: e.g

- Genetic diseases eg: sickle cell anaemia
- Familial diseases eg: type II diabetes & breast cancer.
- Psychiatric heritable diseases.

Menstrual history in details:

(Age at menarche, Last menstrual period, Cycle length, Duration of flow, Amount of flow, Associated pain (dysmenorrheal) and Intermenstrual bleeding).

obstetric history:

- Details of all previous pregnancies (including miscarriages and terminations), length of gestations, date and place of delivery, onset of labor (including details of induction of labor) , mode of delivery , sex and birth weight , fetal and neonatal life , breastfeeding and weaning.
- Clear details of complications or adverse outcomes (eg: shoulder dystocia, post-partum hemorrhage, still birth).

3- Physical Examination including:

A. General examination:

- Weight, height and BMI.
- Vital signs (BP, Pulse, Temperature and Respiratory rate).
- Peripheral oedema and pelvic examination

Inspection of the patient's face for:

- Jaundice which may be associated with obstetric cholestasis
- Melasma which is a benign dark and irregular hyperpigmented macules&considereda non-pathological sign associated with pregnancy
- Oedema associated with pre-eclampsia
- Conjunctival pallor associated with anaemia.

B. abdominal examination:

- Inspection:

The abdomen was exposed appropriately, from the xiphisternum to the symphysis pubis and was inspected for any relevant clinical signs:

o The shape of the abdomen.

o Fetal movements.

o Surgical scars (e.g. previous caesarean section scar)

o Cutaneous signs of pregnancy:

o Linea nigra

o Striae gravidarum

o Striae albicans

• Palpation

- The patient was asked about any abdominal tenderness before palpating the abdomen and the patient's face was noticed for signs of discomfort during the examination.

- Superficial palpation in each of the abdominal 9 regions was performed with monitoring of any tenderness, guarding, or masses (other than the gravid uterus itself).

- Palpation of the uterus done to recognize the borders of the uterus, feeling its upper and lateral margins.

- Fundal level was examined.

- Fetal lie was examined by hands placed either side of the uterus and applying gentle pressure to each side to locate the side of fetal back and the side of fetal limbs.

- Presentation was examined by placing the hands either side of the lower pole of the uterus and a firm pressure angled medially is applied to feel the presenting part.

- Symphyseal-fundal height was measured by measuring the distance between the uterine fundus and the upper border of the pubic symphysis in centimeters with a tape measure.

- The fetal heartbeat was monitored by Fetal Doppler.

C. INVESTIGATION

Routine investigation, biochemical tests (CBC, random blood sugar, urine analysis, liver and kidney function tests).

D. Abdominal Ultrasound

Was performed using Mindray Dc_70 ultrasound.

- Biparietal diameter

The BPD was measured as follows: with an axial plane through a symmetrical calvarium, that includes the third ventricle, thalami, falx cerebrum, and cavum septipellicidi anteriorly, and the tentorial hiatus posteriorly.

- The calipers were placed at the maximal diameter, from the outer edge of the proximal skull wall, to the inner edge of the distal skull.

. The fetal kidney length was measured as follows:

The fetal kidney length was measured from 28 weeks till 38 weeks of gestation.

Kidneys were identified first in transverse section just below the level of AC measurement, and then the probe was being rotated longitudinally (90) till full length of kidney was identified. The kidney length was taken as a bipolar measurement cautiously. In measuring FKL the adrenal gland must to be identified and excluded from measurement. Fetal kidney length was obtained in sagittal plane, when full length of the kidney and renal pelvis is visualized. Average of 3 measurements in centimeters of the kidney was recorded and the mean measurement was taken. the measurements were performed using gray scale real time ultrasonographic scanner with 3.5-5 MHz curvilinear transducer. Appropriate statistical analysis was done.

Both kidneys were measured.the proximal kidney (nearer to probe) was easier and more accurate measure.

Statistical analysis

Data were collected, tabulated, statistically analyzed using an IBM personal computer with Statistical Package of Social Science (SPSS) version 22 (SPSS, Inc, Chicago, Illinois, USA) where the following statistics were applied: Descriptive statistics: in which quantitative data were presented in the form of mean (X), standard deviation (SD), range, and qualitative data

were presented in the form numbers and percentages. Analytical statistics used to find out the possible association between studied factors and the targeted disease. The used tests of significance included: Chi-square test (χ^2) was used to study association between two qualitative variables. Student t-test is a test of significance used for comparison between two groups having quantitative variables. P value of <0.05 was considered statistically significant

Results:

1. Characteristics of the study participants, obstetric history, and fetal gender

Table (1) shows that there was statistically significant difference between the 2 groups regarding gestational age by US in weeks ($p < 0.001$). There was no statistically significant difference between the 2 groups regarding age in years, gravidity, parity, and gestational age by LMP in weeks as ($p = 0.106$), ($p = 0.343$), ($p = 0.360$), ($p = 0.865$).

Table (1): Demographic characteristics, obstetric history and fetal gender of the studied patients.

	IUGR group (n= 50)	Control group (n= 50)	95% CI	p
Age (years)	30.14 ± 5.135	28.38 ± 5.649	- 0.38, 3.90	0.106
Gravidity	2.40 ± 1.212	2.64 ± 1.306	-0.74, 0.26	0.343
Parity	1.20 ± 0.969	1.38 ± 0.987	-0.57, 0.21	0.360
Gestational age by LMP (weeks)	33.70 ± 3.671	33.58 ± 3.345	-1.27, 1.51	0.865
Gestational age by US (weeks)	30.96 ± 3.631	33.52 ± 3.412	-3.96, -1.2	**< 0.001**
Data is expressed as mean and standard deviation or as percentage and frequency. P is significant when < 0.05.				

2. Distribution of women age in the studied groups.

Figure 1 shows age distribution between the studied groups.

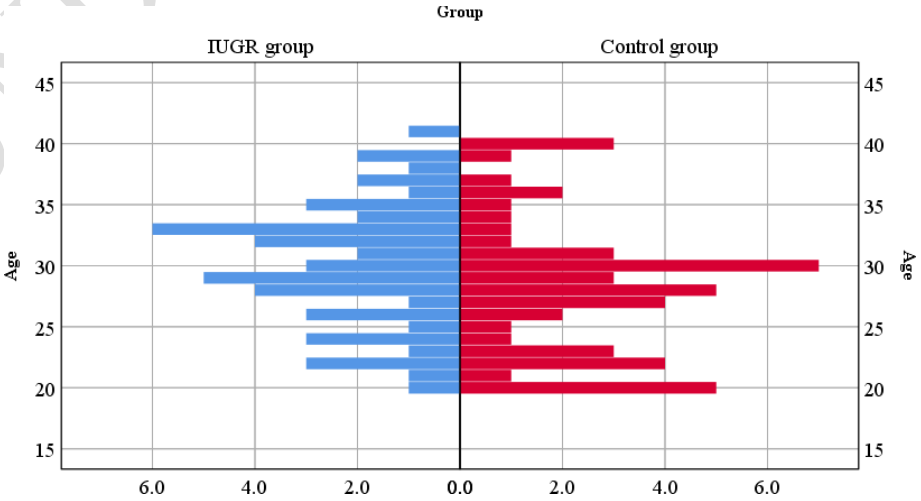

Figure (1): Age distribution in the studied groups.

3. Fetal biometry of the studied patients.

Table 2 shows that as regards (EFBW, BPD, FL, and AC) there was a statistically significant difference between the 2 studied groups.

Table (2): Fetal biometry of the studied patients:

	IUGR group (n= 50)	Control group (n= 50)	95% CI	p
Estimated fetal weight (gm)	1710.8 ± 553.29	2607.0 ± 681.04	-1142, - 649	**< 0.001**
BPD (mm)	65.00 ± 7.594	81.78 ± 7.536	- 19.78, -13.78	**< 0.001**
FL (cm)	3.56 ± 0.415	4.29 ± 0.497	-0.90, -0.54	**< 0.001**
AC (cm)	25.70 ± 2.507	30.91 ± 2.960	-6.31, -4.13	**< 0.001**
Data is expressed as mean and standard deviation. P is significant when < 0.05.				

4. Fetal doppler study of the studied patients.

Table 3 and figure2 shows that as regards (umbilical RI, umbilical PI, umbilical SD, MCA RI, MCA PI, and MCA SD) there was a statistically significant difference between the 2 studied groups.

Table (3): Fetal doppler study of the studied patients.

		IUGR group (n= 50)	Control group (n= 50)	95% CI	p
Umbilicus	Umbilical RI	0.71 ± 0.149	0.65 ± 0.109	0.01, 0.12	**0.015**
	Umbilical PI	1.32 ± 0.336	1.13 ± 0.338	0.06, 0.33	**0.005**
	Umbilical SD	2.54 ± 0.471	2.23 ± 0.428	0.13, 0.49	**0.001**
MCA	MCA RI	0.65 ± 0.129	0.59 ± 0.138	0.01, 0.11	**0.027**
	MCA PI	1.52 ± 0.379	1.35 ± 0.311	0.03, 0.31	**0.016**
	MCA SD	3.21 ± 0.596	2.88 ± 0.603	0.09, 0.57	**0.007**
	Data is expressed as mean and standard deviation. P is significant when < 0.05.				

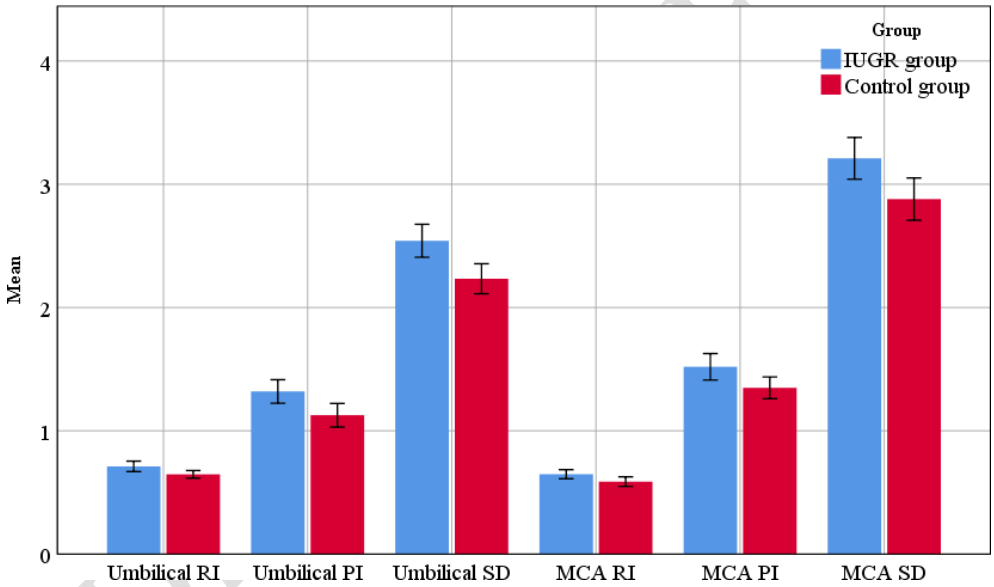

Figure (2): Fetal doppler study of the studied patients.

5. Fetal kidney size (mm) of the studied patients.

Table 4 and figure 3 shows that as regards (The right kidney length and width, left kidney length and width) there was no statistically significant difference between the 2 studied groups.

Table (4): Fetal kidney size (mm) of the studied patients.

	IUGR group (n= 50)	Control group (n= 50)	95% CI	p
Right kidney length	35.28 ± 3.832	35.28 ± 3.442	-1.45, 1.44	0.998
Right kidney width	20.26 ± 2.256	20.22 ± 2.033	-0.81, 0.89	0.926
Left kidney length	38.40 ± 4.000	38.17 ± 3.637	-1.29, 1.74	0.768
Left kidney width	23.09 ± 2.339	23.16 ± 2.341	- 1.00, 0.86	0.881
Data is expressed as mean and standard deviation. P is significant when < 0.05.				

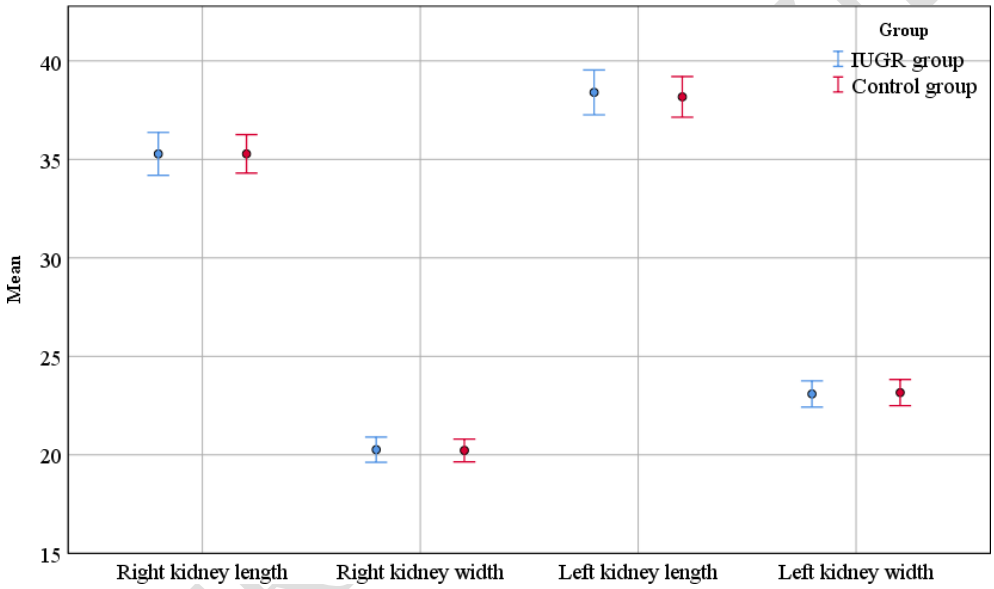

Figure (3): Fetal kidney size (mm) of the studied patients.

6. Correlation between Fetal kidney length and other studied parameters of the studied patients.

Table 5, figures (4-13) are showing that, there were significant positive correlations between different study variables. Gestational age, fetal weight, BPD, FL, and AC were found to be positively correlated with right kidney length and they also found to be positively correlated with left kidney length.

Table (5): Correlation between Fetal kidney length and other studied parameters of the studied patients.

	Right kidney length		Left kidney length	
	Correlation coefficient	**P**	**Correlation coefficient**	**P**
Gestational age	0.978	**< 0.001**	0.937	**< 0.001**
Fetal weight	0.700	**< 0.001**	0.637	**< 0.001**
BPD	0.508	**< 0.001**	0.459	**< 0.001**
FL	0.481	**< 0.001**	0.442	**< 0.001**
AC	0.617	**< 0.001**	0.567	**< 0.001**
P is significant when < 0.05.				

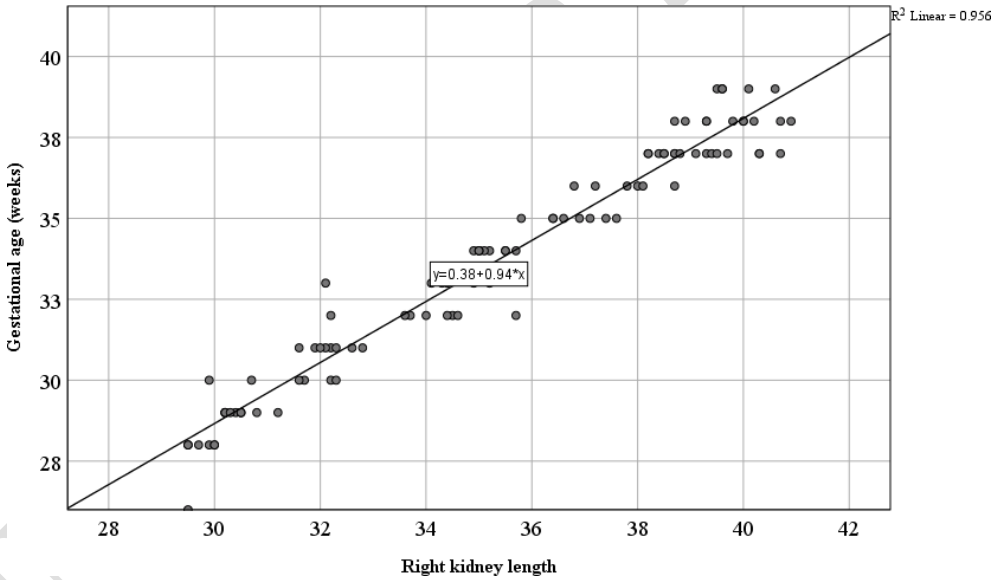

Figure (4): Correlation between right fetal kidney length and Gestational age of the studied patients.

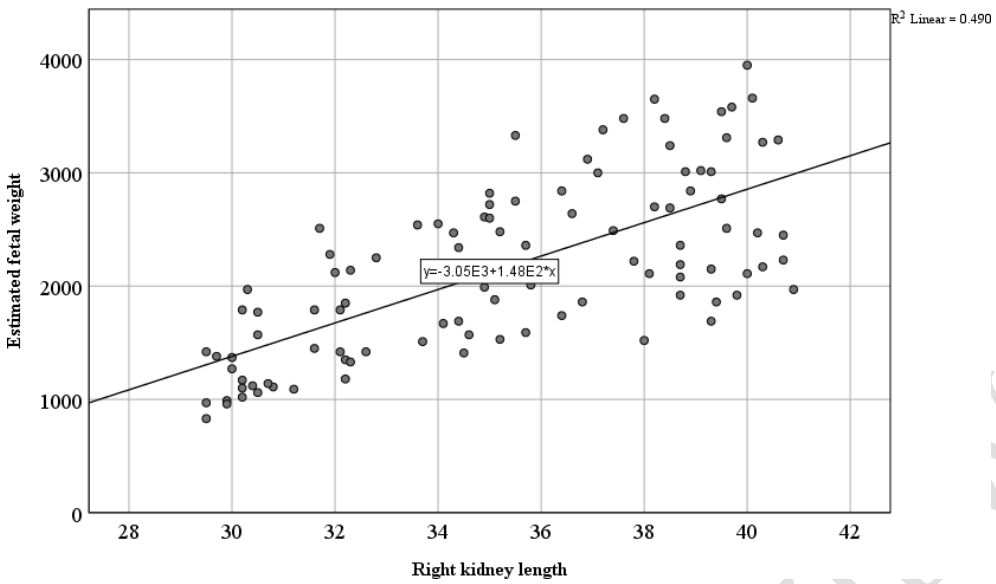

Figure (5): Correlation between right fetal kidney length and Fetal weight of the studied patients.

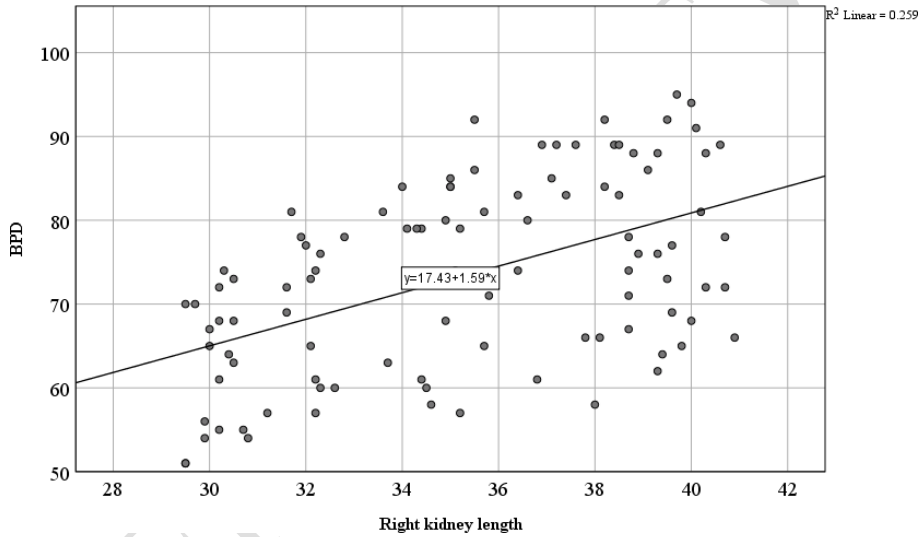

Figure (6): Correlation between right fetal kidney length and BPD of the studied patients.

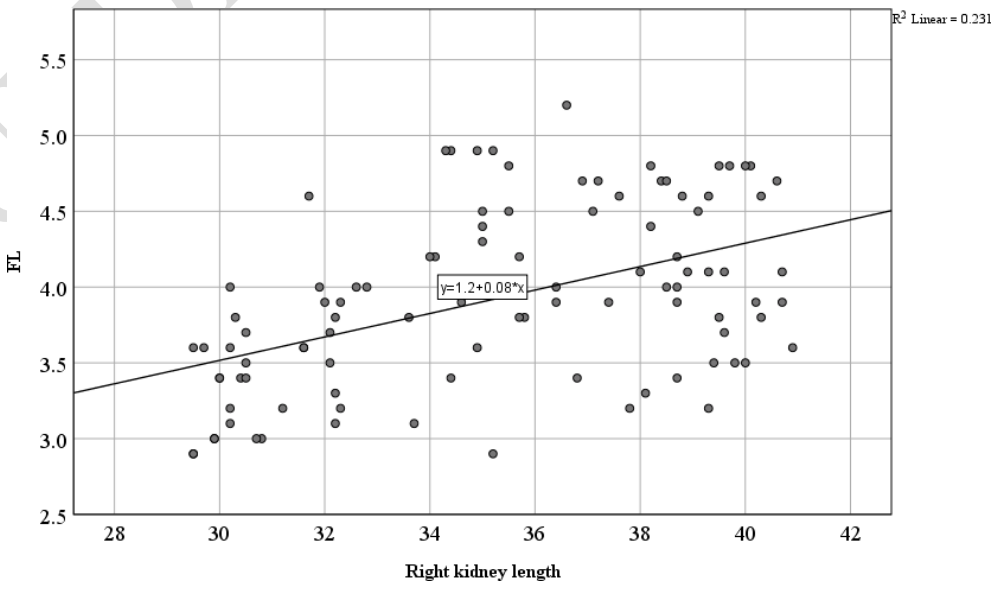

Figure (7): Correlation between right fetal kidney length and FL of the studied patients.

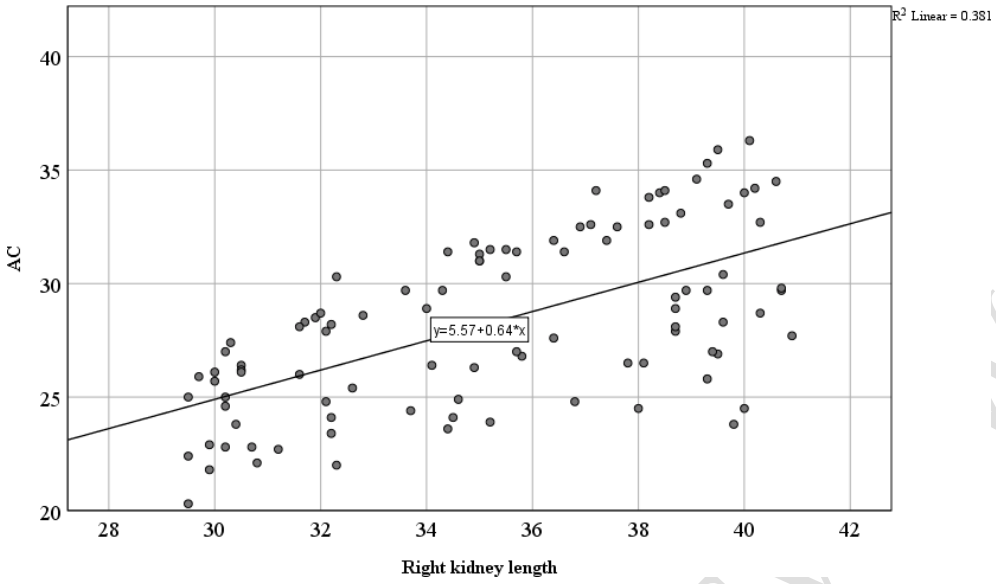

Figure (8): Correlation between right fetal kidney length and AC of the studied patients.

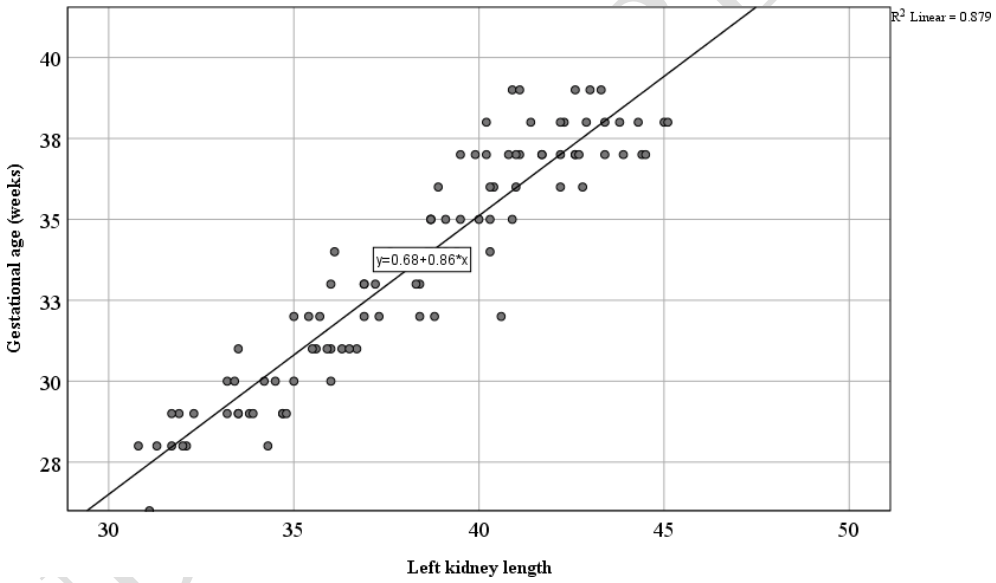

Figure (9): Correlation between left fetal kidney length and Gestational age of the studied patients.

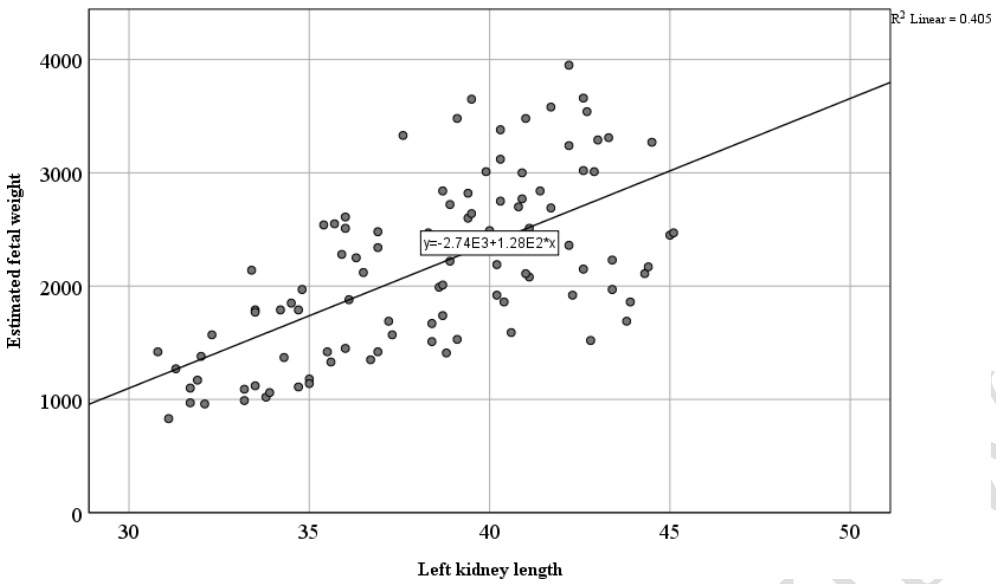

Figure (10): Correlation between left fetal kidney length and Fetal weight of the studied patients.

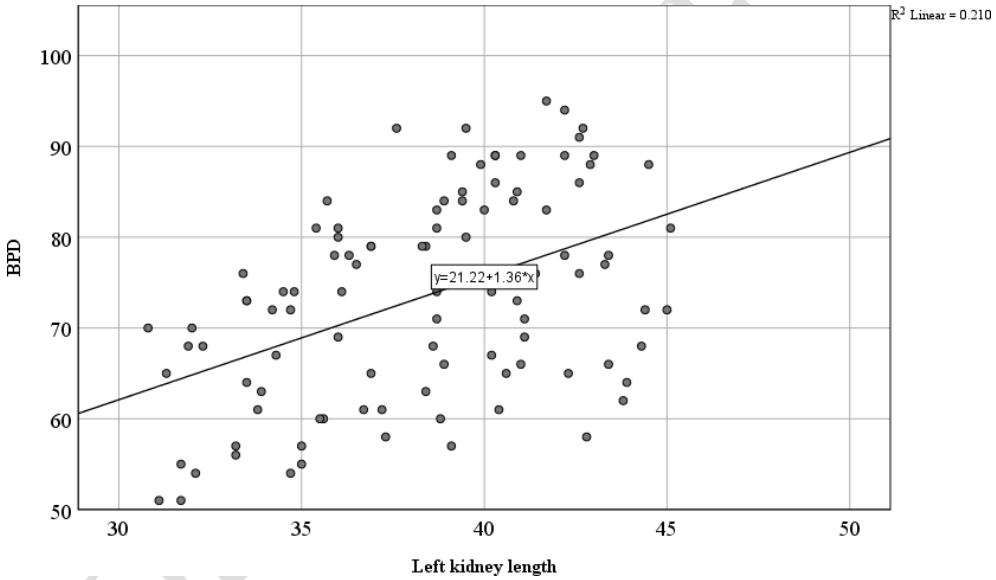

Figure (11): Correlation between left fetal kidney length and BPD of the studied patients.

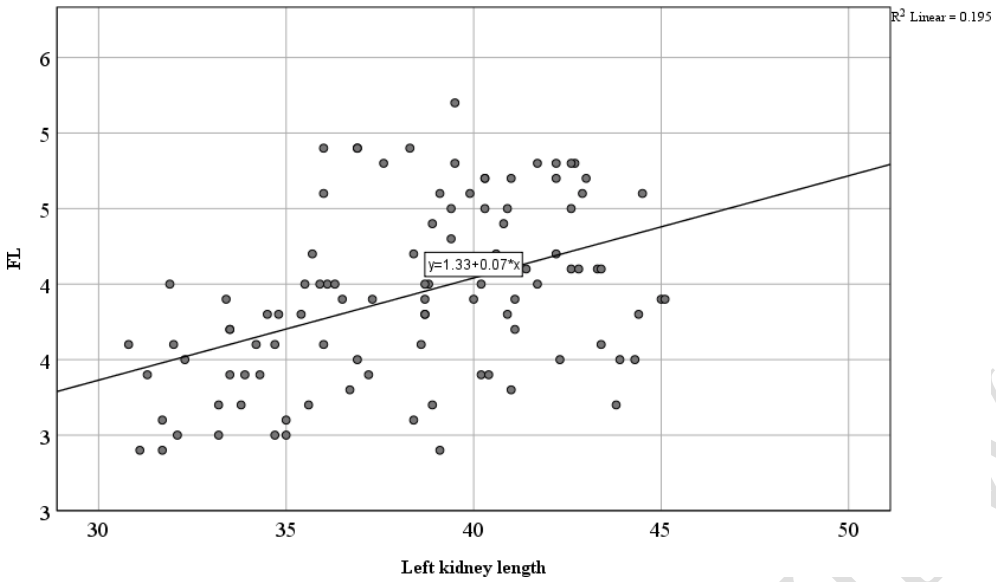

Figure (12): Correlation between left fetal kidney length and FL of the studied patients.

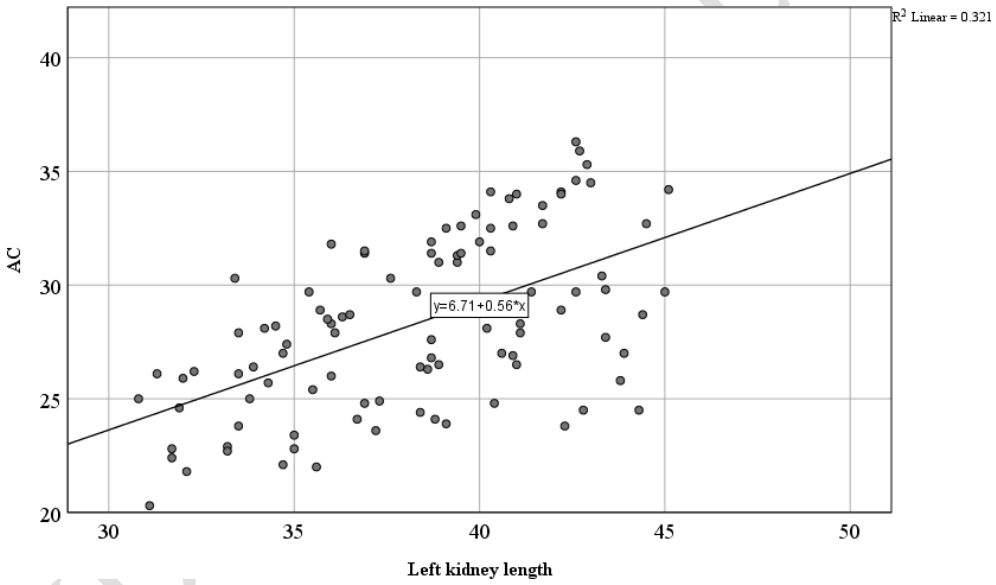

Figure (13): Correlation between left fetal kidney length and AC of the studied patients.

7. Correlation between Fetal kidney width and other studied parameters of the studied patients.

Table 6, figures (14) are showing that, there were significant positive correlations between different study variables. Gestational age, fetal weight, BPD, FL, and AC were found to be positively correlated with right kidney width and they also found to be positively correlated with left kidney width.

Table (6): Correlation between Fetal kidney width and other studied parameters of the studied patients.

	Right kidney width		Left kidney width	
	Correlation coefficient	**P**	**Correlation coefficient**	**P**
Gestational age	0.927	**< 0.001**	0.809	**< 0.001**
Fetal weight	0.659	**< 0.001**	0.593	**< 0.001**
BPD	0.482	**< 0.001**	0.438	**< 0.001**
FL	0.458	**< 0.001**	0.454	**< 0.001**
AC	0.571	**< 0.001**	0.516	**< 0.001**
P is significant when < 0.05.				

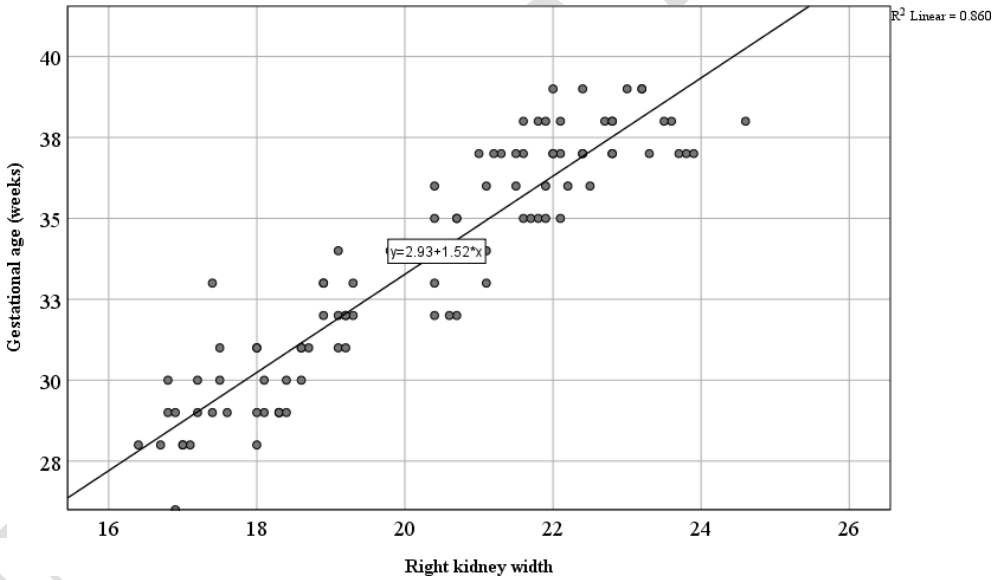

Figure (14): Correlation between right fetal kidney width and Gestational age of the studied patients.

Discussion

With the increased use of ultrasonography in obstetrics, it has been noted that the incidence of renal disease in the prenatal and neonatal period is approximately 10% of all pregnancies. Many abnormalities are minor and have no clinical significance, whereas the frequency of major malformations of the kidney, excluding polycystic kidneys, has been estimated as 4–7 in 1000 fetuses **Treves et al.** (16)**.** So, this case control study was conducted

to assess the ultrasonographic fetal kidney length as a measure of gestational age in third trimester.

In this study, the mean age in years of women in the IUGR group (30.14 ± 5.135) was higher than women in the control group (28.38 ± 5.649).while the mean gravidity among women in the control group (2.64 ± 1.306) was more than women in the IUGR group (2.40 ± 1.212) .

The mean parity among women in the control group (1.38 ± 0.987) was more than women in the IUGR group (1.20 ± 0.969). The mean gestational age in weeks as calculated from last reliable menstrual peroid was (33.70 ± 3.671) in the IUGR group while it was (33.58 ± 3.345) in the control group.

In this study, there was no statistically significant difference between the 2 groups regarding maternal age in years, gravidity, parity as (p=0.106), (p =0.343), (p =0.360). This was similar to **Silver et al.** (17) study in which There were no significant differences between groups with respect to maternal age, parity, pre pregnancy weight, body mass index, blood pressure values, smoking history, marital status, ethnicity.

This study has founded that there was no statistically significant difference between the 2 groups regarding gestational age in weeks as (p=0.865). This is in line with previous studies as **Silver et al.** (18) have founded that the mean gestational age at the time of the ultrasound evaluation did not differ between the two groups (median, 36.5 weeks [range, 29.6-39.6 weeks] and 36.3 weeks [range, 27.6-40.4], IUGR vs no IUGR, respectively).

In this study, the IUGR group most of women's age was distributed between 25 and 35 years old while in the control group most of women's age was distributed around 30 years old.

This study has founded that there was statistically significant difference between the 2 groups regarding the estimated fetal weight in grams as (p <0.001). In the IUGR group the estimated fetal weight in grams (1710.8 ± 553.29) was lower than in the control group (2607.0 ± 681.04).

This study agrees with **Silver et al.** (19) study in which the range of the estimated fetal weight percentiles for the two groups at the time of the ultrasound evaluation. All but 2 of the

fetuses with IUGR had EFWs <10th percentile for gestational age. Two fetuses met the criteria for IUGR by having only abdominal circumferences of <10th percentile. Of the 34 fetuses with IUGR, 29 fetuses (85.3%) were classified as having asymmetric IUGR.

This study agrees **Senra et al.** study [20] in which the growth-restricted group presented a lower mean Total Renal Volume/ Estimated Fetal Weight (TRV/EFW) than the normal group, and the difference was statistically significant.

In the present study, there was statistically significant difference between the 2 groups regarding the BPD (mm) as ($p < 0.001$). In the IUGR group the BPD (mm) (65.00 ± 7.594) was lower than in the control group (81.78 ± 7.536).In the control group the FL (cm) (4.29 ± 0.497) was higher than in the IUGR group (3.56 ± 0.415), with statistically significant difference between the 2 groups ($p < 0.001$).The AC (cm) in the IUGR group was (25.70 ± 2.507) which was lower than in the control group (30.91 ± 2.960), with statistically significant difference between the 2 groups ($p < 0.001$).

Similarly, agreeing to the present study, the subjects with IUGR had smaller abdominal circumferences, biparietal diameters, femur lengths, EFW, EFW percentiles, and lower amniotic fluid indices than did the subjects with no IUGR **Skovron et al.** [21].

This study has founded that the fetal doppler study of the studied patients, the mean umbilical RI, umbilical PI, umbilical SD in the IUGR group (0.71 ± 0.149), (1.32 ± 0.336), (2.54 ± 0.471) were more than them in the control group (0.65 ± 0.109), (1.13 ± 0.338), (2.23 ± 0.428) with statistically Significant difference between the 2 groups ($p = 0.015$), ($P = 0.005$), ($P = 0.001$).

In this study, there is statistically Significant difference between the 2 groups regarding MCA RI, MCA PI, MCA SD as, ($p = 0.027$), ($P = 0.016$), ($P = 0.007$). in the IUGR group the means MCA RI, MCA PI, MCA SD (0.65 ± 0.129), (1.52 ± 0.379), (3.21 ± 0.596) were higher than them in the control group (0.59 ± 0.138), (1.35 ± 0.311), (2.88 ± 0.603).

In the present study, it was founded that the mean right kidney length and width were about to be similar in both groups as the right kidney mean length in the IUGR group was (35.28 ± 3.832) while in the control group it was (5.28 ± 3.442). The right kidney mean width in the IUGR group was (20.26 ± 2.256) while in the control group it was (20.22 ± 2.033),

with no statistically difference between the 2 groups regarding the length and width (p= 0.998), (p= 0.926).

In this study, the mean left kidney length and width were about to be similar in both groups as the left kidney mean length in the IUGR group was (38.40 ± 4.000) while in the control group it was (38.17 ± 3.637). The left kidney mean width in the IUGR group was (23.09 ± 2.339) while in the control group it was (23.16 ± 2.341), with no statistically difference between the 2 groups regarding the length and width (p= 0.768), (p= 0.881).

So, in this study the differences between the left and right kidney measurements were minimal and the measurements of the left and right kidneys in the IUGR group was normal. This was similar to **Konje et al.** [22] study there was no statistically significant difference between the measurements of the left and right kidneys (P > 0.05).

On the contrary to Schmidt et al. [23] study in which Intrauterine growth restriction has been associated with reduced kidney volume in human fetuses of known gestational age. It is possible that the decrease in renal size that is seen in the fetuses with IUGR is due to alterations in renal artery blood flow.

In **cahng et al. study** [24]**,** the fetal RV in FGR fetuses was significantly smaller than that in non-FGR fetuses ($p < 0.001$).

In contrast to **Verburg et al.** [25] study that founded no relation between growth restricted fetuses with kidney volume and the decrease in renal size.

In this study, there were significant positive correlations between different study variables. Gestational age, fetal weight, BPD, FL, and AC were found to be positively correlated with right kidney length and they also found to be positively correlated with left kidney length. Like **Konje et al.** [26] study in which there was a significant correlation between gestational age (weeks) and kidney length (mm), $r = 0.94$ ($P < 0.002$).

This study had founded that there were significant positive correlations between different study variables. Gestational age, fetal weight, BPD, FL, and AC were found to be positively correlated with right kidney width and they also found to be positively correlated with left kidney width.

In **Verburg et al.** study the smaller fetal body size is associated with smaller kidneys, but these kidneys are relatively large for that body size [27]. **Konje et al. and Gloor et al.** studies suggested that the ratio of kidney volume with estimated fetal weight or abdominal circumference is constant in fetuses with different size and age [28].

In this study, Kidney length (mm) and Kidney width (mm) have positive and statistically significant impact on determining gestational age. Like **Konje et al.** [29] study that reported that the mean kidney length increased from 24.2 ± 1.2 mm at 24 weeks' gestation to 40.1 ± 2.4 mm at 38 weeks' gestation.

In this study, there were no statistically significant differences between the male and females studied patients regarding right & left kidney length, right kidney width, left kidney length, and left kidney width (p value is > 0.05).The mean right kidney length, the mean right kidney width, the mean left kidney length, and the mean left kidney width were about to be similar in both male and females studied patients. This was like **Silver et al.**[30] Study in which there was no differences in fetal sex between the neonates with IUGR and with no IUGR, and similar to **Konje et al.** [31] Study that had there were no sex differences in the renal and fetal biometric indices.

Conclusions:

In absence of renal anomalies/ abnormalities, kidney measurements; length, weight, volume can be used to determine gestational age accurately.

No difference between measuring Rt or Lt kidney on determining GA. Also, no difference between measurements in female or male fetuses.

Kidney measurement is not affected in cases of IUGR and can be used as a reliable indicator for actual gestational age of the fetus in these cases.

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COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is

absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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