Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Radiology

Ultrasound Evaluation of Hydronephrosis of Pregnancy in the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria

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DOI: 10.36347/sjams.2023.v11i04.024 | **Received:** 07.03.2023 | **Accepted:** 25.04.2023 | **Published:** 29.04.2023

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Abstract **Original Research Article**

Background: Pregnancy is associated with dilatation of the collecting systems of the kidneys. However in most pregnant women hydronephrosis goes un-recorded and may only become evident when symptoms develop. The incidence of hydronephrosis in pregnancy is yet to be determined in our environment hence the need to determine the incidence and associated factors in Port Harcourt. This study was done to evaluate pregnant women in the second and third trimesters and to determine the incidence of hydronephrosis with respect to parity, gestational age and commonest side of occurrence. ***Materials and Methods:*** A prospective, descriptive cross sectional study involving 190 pregnant patients referred to the Radiology Department of the University of Port Harcourt Teaching Hospital between August 2012 and July 2013. Their demographic data and Ultrasonographic findings were obtained. Data was analyzed using statistical package for social sciences (SPSS) version 20. ***Results and Discussions:*** The ages of the women ranged from 18 to 42 years however the age group (27 – 30) years had the highest incidence of hydronephrosis of pregnancy. Of the 190 pregnant women, 74 were in their second trimester of pregnancy and 116 were their third trimester. Thirty three percent of the patients in the study group has normal Right pelvicalyceal diameter while 66.3% has Right pelvicalyceal dilatation. 51.1% has normal Left pelvicalyceal diameter and 48.9% has Left pelvicalyceal dilatation. Pearson correlation test shows a positive but not significant correlation between gestational age and both Right pelvicalyceal dilatation (p= 0.416) and Left pelvicalyceal dilatation (p= 0.191). ***Conclusions:*** Hydronephrosis of pregnancy is common and predominantly occurs on the right. Pelvicalyceal dimensions increases throughout pregnancy with increasing gestational age as well as increasing parity.

Keywords: Pregnancy, Hydronephrosis, pelvicalyceal dilatation.

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INTRODUCTION

Hydronephrosis is a common finding in pregnancy. The term hydronephrosis is used to describe the dilatation of the pelvicalyceal system. Hydronephrosis in pregnancy could be physiological or pathological. In physiological hydronephrosis of pregnancy, dilatation is usually more prominent in the right kidney with absence of involvement of the ureters below the pelvic brim and regression of the dilatation several weeks post-partum. Dilatation may result from ureteral compression by the gravid uterus and the effect of progesterone on the urinary tract. [1, 2] Dilatation of the urinary tract in pregnancy is a physiological phenomenon. However, the course and pattern of dilatation in our environment is unknown. Also, the literature is replete with information regarding hydronephrosis in Pregnancy in other countries and in this environment. Hydronephrosis in pregnancy though usually asymptomatic may eventually progress to give rise to flank pain, recurrent pyelitis and in rare cases renal failure. Hence the necessity to establish parameters to guide the assessment of hydronephrosis in pregnancy and aid intervention where necessary. A lot of controversies surround the pattern of dilatation throughout pregnancy and there is paucity of literature on criteria to define hydronephrosis of pregnancy among Nigerians. Ultrasonography is an important imaging modality and the modality of choice in the evaluation of hydronephrosis in pregnancy [3] as it is noninvasive, accessible, cheap, and does not use ionizing radiation which is detrimental to the fetus. So far there are no documented adverse effects from diagnostic ultrasound. Studies have documented the ability of ultrasound to detect moderate and severe hydronephrosis. It has also been stated that ultrasound can detect mild hydronephrosis.[4] Another imaging modality which is useful and safe in pregnancy is Magnetic Resonance Imaging (MRI). MRI has been in use for evaluation in obstetrics and fetal diseases for

over 30 years. There has been no evidence of harmful effects to the fetus. However the primary safety concerns are the heating effects of radiofrequency pulses and acoustic noise. MRI is however expensive and most times inaccessible in our clinical settings [5]. Ultrasound Evaluation of Hydronephrosis of Pregnancy has been extensively studied in the Caucasian population [1, 2, 6, 7, 8-10] but studies from Nigeria have been relatively scanty [10]. Oyinloye *et al.* [10] studied the Evaluation of Hydronephrosis during Pregnancy in Nigerian women at the Federal Medical Center, Lokoja [10]. This study aims at evaluating hydronephrosis of pregnancy using Ultrasound in the University of Port Harcourt Teaching Hospital as no such study has been done in this center. The study was aimed to broadly evaluating the sonographic features of hydronephrosis of pregnancy in Port Harcourt. It was also aimed to specifically determine the degree and pattern of calyceal dilatation in the second and third trimesters of pregnancy as well as to determine the incidence of hydronephrosis of pregnancy in the left and right kidneys as separate entities. Finally, the study seeks to determine the correlation between past urinary tract disease in the study subjects and the degree of calyceal dilatation observed.

METHODOLOGY

This study was a hospital based cross sectional prospective, descriptive study carried out in the radiology Department of the University of Port Harcourt Teaching Hospital over a period of one year spanning August 2012 and July 2013. The study sampled pregnant subjects sent to the Department of radiology UPTH for routine Obstetric ultrasound scan. Ethical approval for the study is contained in a letter with Ref UPTH/ADM/90/S.11/VoL X/215. A total of 190 participants (who volunteered) were recruited from the gravid patients (primiparous and multiparous) sent to the Department from the antenatal clinic for sonography as well as (primiparous and multiparous) nonpregnant women of child bearing age recruited as controls. Hence two (2) groups of women were scanned: 140 Gravid (primiparous and multiparous) and 50 Nongravid.All Subjects without pelvic masses as well as those with pre-eclampsia or chronic hypertension were excluded.

The procedure was explained to all the subjects prior to the study and they were allowed to volunteer to participate in the study. Informed consent was obtained.

Questionnaires were then administered to obtain the participants biodata and demographics in order to establish their age, parity, gestational age of pregnancy, weights and heights. The Questionnaires were also to exclude the presence of urinary tract symptoms and chronic renal disease. Demographic data of all the subjects were recorded and the body mass index (BMI) calculated. Real time ultrasound scanning was done using Aloka 2500 machine with a 3.5–5 mHz curvilinear multivariable transducer.

The subjects were asked to empty their bladder prior to the ultrasound scan to avoid the possible effects of full bladder on the upper urinary tract. The right kidney was scanned through the left posterior oblique or left lateral decubitus position scanning through the anterior axillary line intercostally or subcostally while the left kidney was scanned in the right posterior oblique or right lateral decubitus position scanning through the anterior axillary line intercostally or subcostally [11].

The severity of hydronephrosis will be assessed by measuring the echolucent pelvicalyceal complex in millimeters from leading edge to leading edge and using a system of grading described by Peake *et al.,* [12] stated below;

Grade 0: normal size, renal pelvicalyceal diameter 0-5mm
Grade I: mild dilatation, renal pelvicalyceal diameter 6-10mm
Grade II: moderate dilatation, renal pelvicalyceal diameter 10-15mm
Grade III: severe dilatation, renal pelvicalyceal diameter >16mm.
Both kidneys were examined individually for the purpose of analysis.

Figure 1: longitudinal scan of the right kidney showing mild pelvicalyceal dilatation

STUDY LIMITATION

Ultrasonography is largely operator dependent and intra-observer and inter-observer variability are typical challenges in ultrasonography.

ETHICAL CONSIDERATIONS

Approval was granted by the ethical committee of the university of Port Harcourt Teaching Hospital before commencement of the study. Participation was voluntary. The study was performed after the benefit and safety of the study had been explained to the patient and an informed consent was obtained.

RESULTS

A total of 240 women of child bearing age, made up of 190 pregnant women (the study group) and 50 non pregnant women (the control group), were scanned. The ages of the women ranged from 18 to 42 years as shown in table 1. Of the 190 pregnant women, 74 were in their second trimester of pregnancy and 116 were in their third trimester. Table 2 shows the distribution of hydronephrosis according to the maternal age groups. The distribution showed that the age group (29 - 38) years has the highest incidence of hydronephrosis of pregnancy. This is followed by (19 - 28) years and (39 - 48) years respectively. Table 3 shows the mean pelvicalyceal diameter of both kidneys of the subjects with hydronephrosis. There was no history of urinary tract infection given by all the patients scanned hence, the relationship between past history of UTI and pelvicalyceal dilatation could not be determined. Test of hypothesis using the T- statistics for paired difference showed that there is a significant difference in the incidence of hydronephrosis of pregnancy between the right and left kidneys ($p < 0.05$). However, the difference in means of pelvicalyceal diameters of the right and left kidneys of the control group is not significant ($p = 0.911$).T-test for independent samples showed that the difference in means of the pelvicalyceal diameter between the study group and the control group is significant ($p = 0.000$) when equal variance is assumed, and ($p = 0.000$) when equal variance is not assumed for the right kidney, and ($p = 0.001$) when equal variance is assumed and ($p = 0.000$) when equal variance is not assumed for the left kidney. The Levene's test for equality of variances was also significant ($p = 0.000$)for the right kidney and ($p = 0.02$) for the left kidney. This implies that pregnancy impacts positively on the probability of developing hydronephrosis. Table 4 shows the Mean and Standard deviation of the pelvicalyceal diameter measurements and gestational age. It was observed that the right and left pelvicalyceal diameter for the pregnant women were higher than that of the nonpregnant women. Table 5: Shows the frequency distribution of Parity of women scanned in this study. The frequency was highest in the study group and control group with no parity. Table 6 shows the frequency distribution of renal pelvicalyceal diameter of the study group for the right and left kidney. It was observed that 57.9% of the result from the right kidneys and 46.3% of the left kidneys had a Mild Dilatation. Table 8 shows the gestational Age and Mean Pelvicalyceal Diameter. It was observed that the Mean Right Pelvicalyceal Diameter was highest in the 38 – 40 week of gestational age. Table 7 shows the frequency distribution of renal pelvicalyceal diameter of the control group. It was observed that 76.0% of right renal pelvicalyceal diameter were normal while 78.0% for the left renal pelvicalyceal diameter were normal. Table 8 shows the gestational Age and Mean Pelvicalyceal Diameter. It was observed that, the highest value for the right Mean Pelvicalyceal Diameter was in week 38 – 40 of gestation.

Table 9 shows the Parity and Mean Pelvicalyceal Diameter. It was observed that, the Mean Pelvicalyceal Diameter increases with Parity. Figure 2 shows the Bar chart of pelvicalyceal dilatation among the study group. Severe pelvicalyceal dilatation was less compared to moderate and mild pelvicalyceal dilatation. Figure 3 shows the Bar chart of pelvicalyceal dilatation among the control group. It was observed that normal pelvicalyceal dilatation was more compared to moderate, mild and Severe pelvicalyceal dilatation. Figure 4 shows the incidence rate of Right and Left kidney hydronephrosis among the study group. It was observed that hydronephrosis was higher in frequency in the right kidney. Figure 5 shows the incidence rate of Right and Left kidney hydronephrosis among the control group. It was observed that normal kidneys were more. Figure 6 shows the correlation between pelvicalyceal diameter and gestational age for the Right Kidney. The Pearson correlation test shows a positive but not significant correlation between gestational age and both Right pelvicalyceal dilatation. Figure 7 shows the correlation between pelvicalyceal diameter and gestational age for the left Kidney. The Pearson correlation test shows a positive but not significant correlation between gestational age and both left pelvicalyceal dilatation.

Table 1: Descriptive statistics of the mean age of the patients

	Frequency	Min. Age	Max. Age	Mean Age	± Std. Dev.
Study group	190 (79.2%)	19years	42years	29.7	±4.6
Control group	50 (20.8%)	18years	37years	26.9	±4.5

Table 2: Hydronephrosis by Maternal Age

Maternal Age (Years)	Proportion with Normal Pelvicalyceal dilatation	Proportion with Hydronephrosis	Total
19 - 28	20 (10.5%)	56 (29.5%)	76 (40.0%)
29 - 38	35 (18.4%)	77 (40.5%)	112 (58.9%)
39 - 48	1 (0.5%)	1 (0.5%)	2 (1.1%)

Table 3: Maternal Age and Mean Pelvicalyceal Diameter.

Maternal Age (Years)	No.	Mean Pelvicalyceal Diameter (cm) Rt. Kidney	Std. ±Deviation	Mean Pelvicalyceal Diameter (cm) Lt. Kidney	Std. ±Deviation
19 – 28	56	0.80	±0.27	0.64	±0.19
29 – 38	77	0.80	±0.27	0.65	±0.18
39 – 48	1	0.60	±0.00	0.70	±0.00

Table 4: Mean and S.D of the pelvicalyceal diameter measurements

Gestation Age	Rt. Renal pelvicalyceal diameter (Mean ± Std. Dev.)	Lt. Renal pelvicalyceal diameter (Mean ± Std. Dev.)
1st Trimester (1 - 13 wks)	-	-
2nd Trimester (14 - 26 wks)	0.69 ± 0.30	0.58 ± 0.18
3rd Trimester (≥ 27wks)	0.69 ± 0.27	0.57 ± 0.21
Control group (No pregnancy)	0.47 ± 0.13	0.47 ± 0.13

Table 5: Frequency distribution of Parity of women scanned in this study

Parity	Study Group Count	Control Group Count (%)	Total
0	68 (28.3%)	31 (12.9%)	99 (41.2%)
1	60 (25.0%)	12 (5.0%)	72 (30.0%)
2	33 (13.8%)	4 (1.7%)	37 (15.5%)
3	16 (6.7%)	2 (0.8%)	18 (7.5%)
4	10 (4.2%)	1 (0.4%)	11 (4.6%)
5	3 (1.2%)	0 (0%)	3 (1.2%)
TOTAL	190 (79.2%)	50 (20.8%)	240 (100.00%)

Table 6: Frequency distribution of renal pelvicalyceal diameter of the study group

Pelvicalycial Dilatation	Right Kidney	Left Kidney
Normal (≤ 5mm)	64 (33.7%)	97 (51.1%)
Mild Dilatation (6 - 10mm)	110 (57.9%)	88 (46.3%)
Moderate Dilatation (11 - 15mm)	11 (5.8%)	4 (2.1%)
Severe Dilatation (≥ 16mm)	5 (2.6%)	1 (0.5%)
TOTAL	190 (100%)	190 (100%)

Table 7: Frequency distribution of renal pelvicalyceal diameter of the control group

Pelvicalycial Dilatation	Right Kidney	Left Kidney
Normal (≤ 5mm)	38 (76.0%)	39 (78.0%)
Mild Dilatation (6 - 10mm)	12 (24.0%)	11 (22.0%)
Moderate Dilatation (11 - 15mm)	0	0
Severe Dilatation (≥ 16mm)	0	0
TOTAL	50 (100%)	50 (100%)

Table 8: Gestational Age and Mean Pelvicalyceal Diameter.

Gestational Age (Weeks)	No.	Mean Pelvicalyceal Diameter (cm)	±Std. Deviation	Mean Pelvicalyceal Diameter (cm)	±Std. Deviation
14 – 16	8	0.71	±0.16	0.60	±0.18
17 – 19	19	0.71	±0.39	0.56	±0.16
20 – 22	17	0.70	±0.28	0.51	±0.17
23 – 25	21	0.67	±0.29	0.60	±0.14
26 – 28	24	0.58	±0.20	0.51	±0.22
29 – 31	25	0.74	±0.38	0.60	±0.26
32 – 34	31	0.62	±0.18	0.54	±0.16
35 – 37	31	0.75	±0.28	0.65	±0.26
38 – 40	15	0.76	±0.24	0.59	±0.09

Table 9: Parity and Mean Pelvicalyceal Diameter.

		Rt. Kidney		Lt. Kidney	
Parity	No.	Mean Pelvicalyceal Diameter (cm)	±Std. Deviation	Mean Pelvicalyceal Diameter (cm)	±Std. Deviation
0	69	0.64	±0.28	0.55	±0.20
1	60	0.71	±0.26	0.59	±0.23
2	33	0.65	±0.23	0.55	±0.16
3	15	0.86	±0.44	0.60	±0.21
4	10	0.76	±0.23	0.64	±0.16
5	3	0.87	±0.31	0.67	±0.06

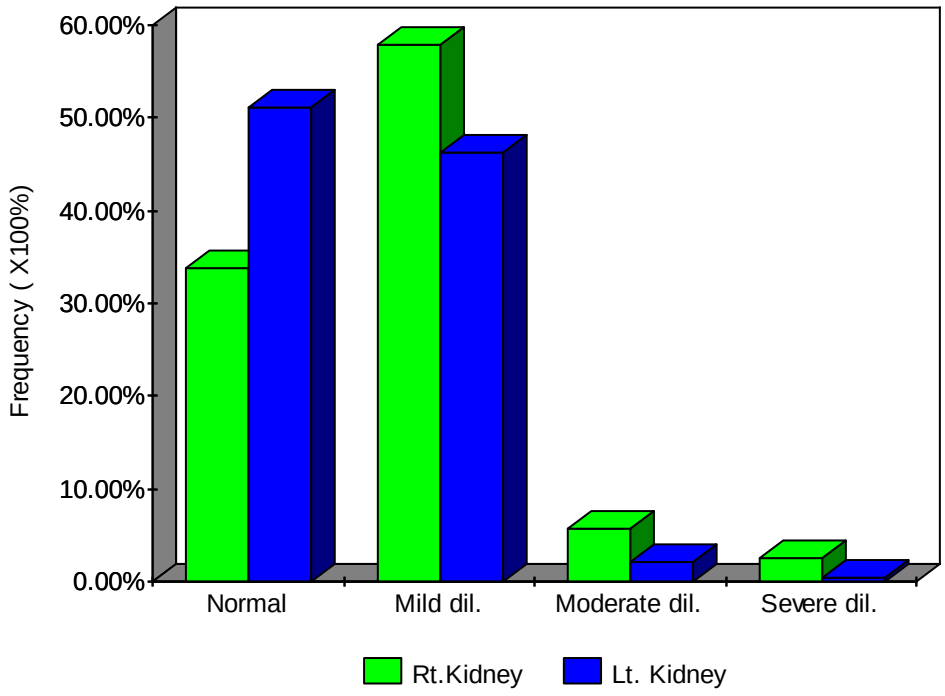

FIG. 2: Bar chart showing pelvicalyceal dilatation among the study group

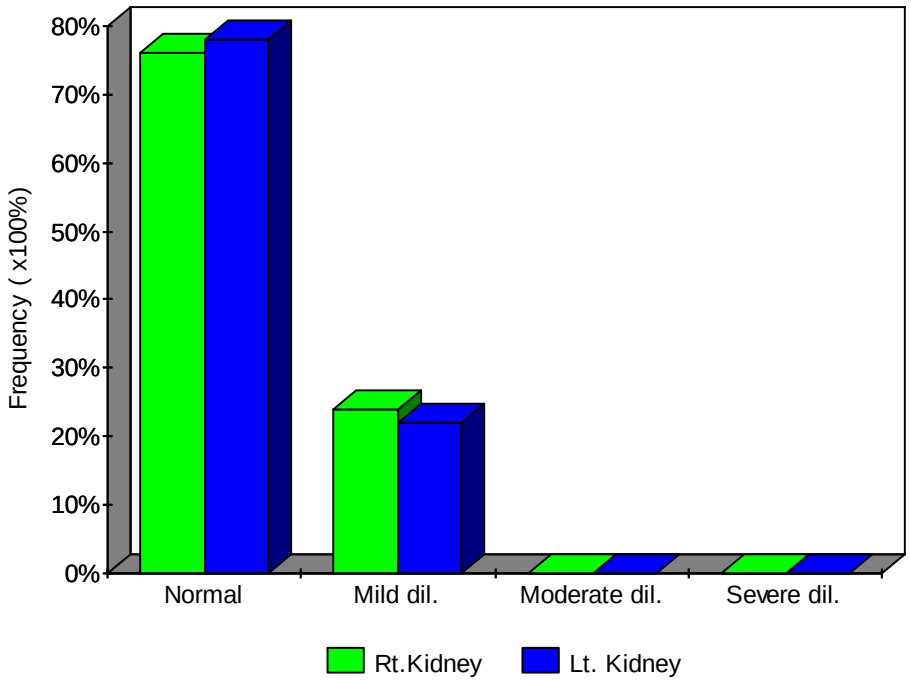

FIG. 3: Bar chart showing pelvicalyceal dilatation among the control group

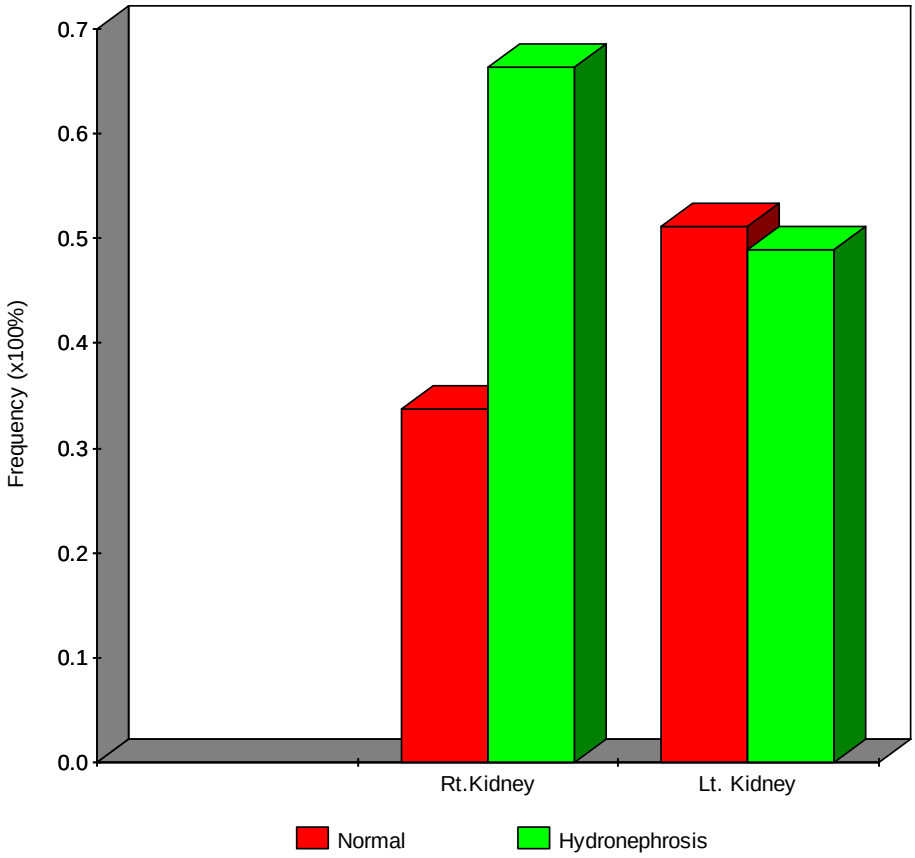

Fig. 4: The incidence rate of Right and Left kidney hydronephrosis among the study group.

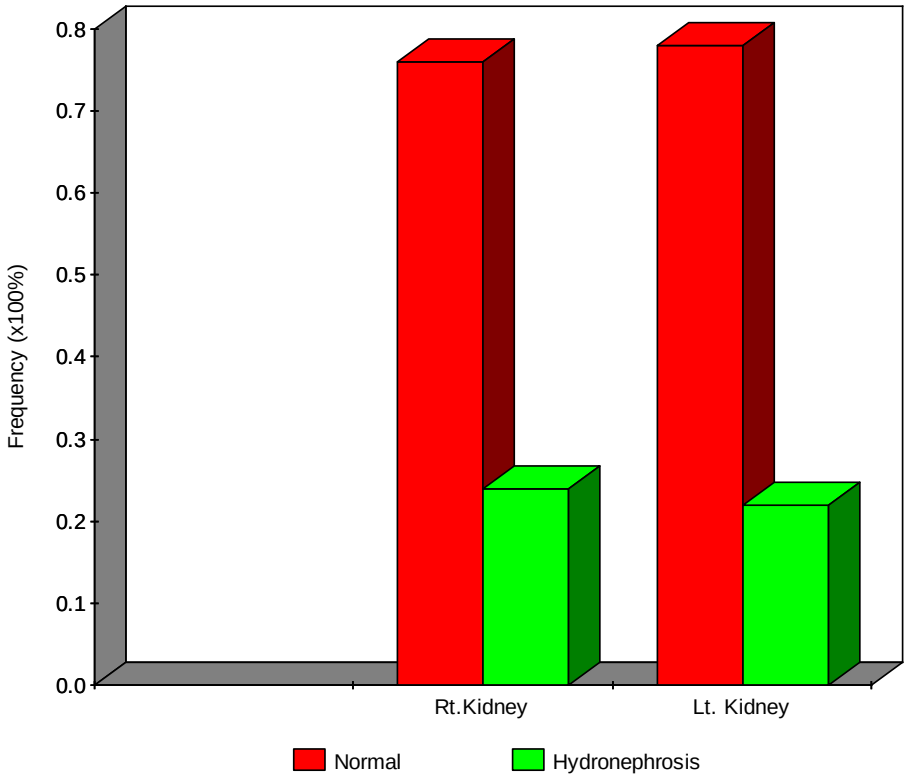

Fig. 5: The incidence rate of Right and Left kidney hydronephrosis among the control group

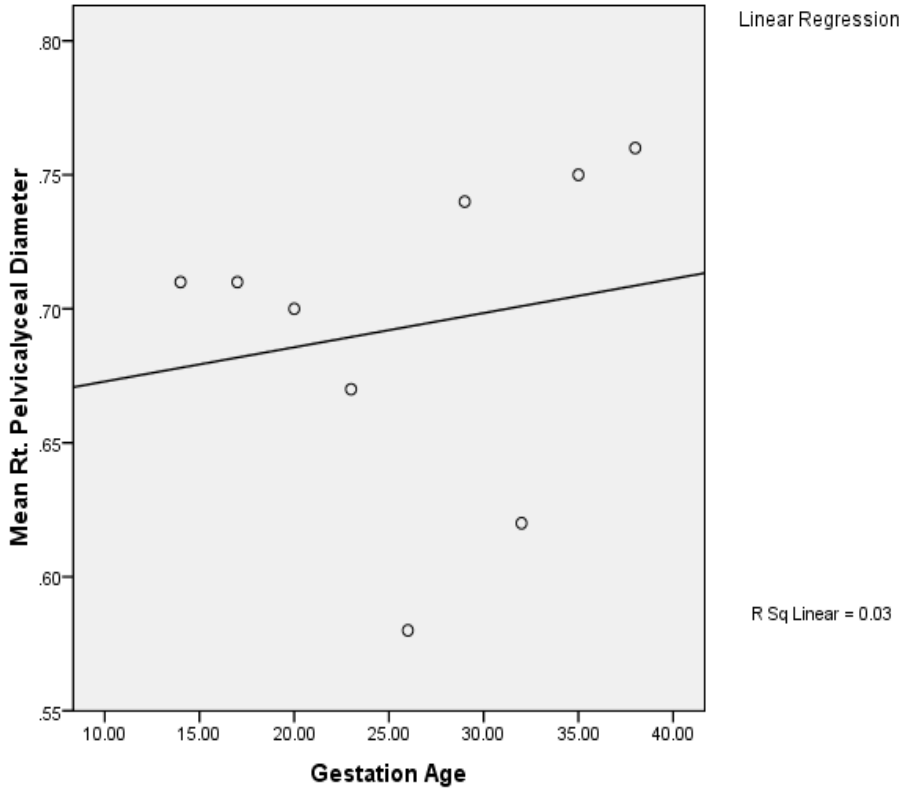

Fig. 6: Scatter plot of pelvicalyceal diameter by gestational age for the Rt. Kidney.

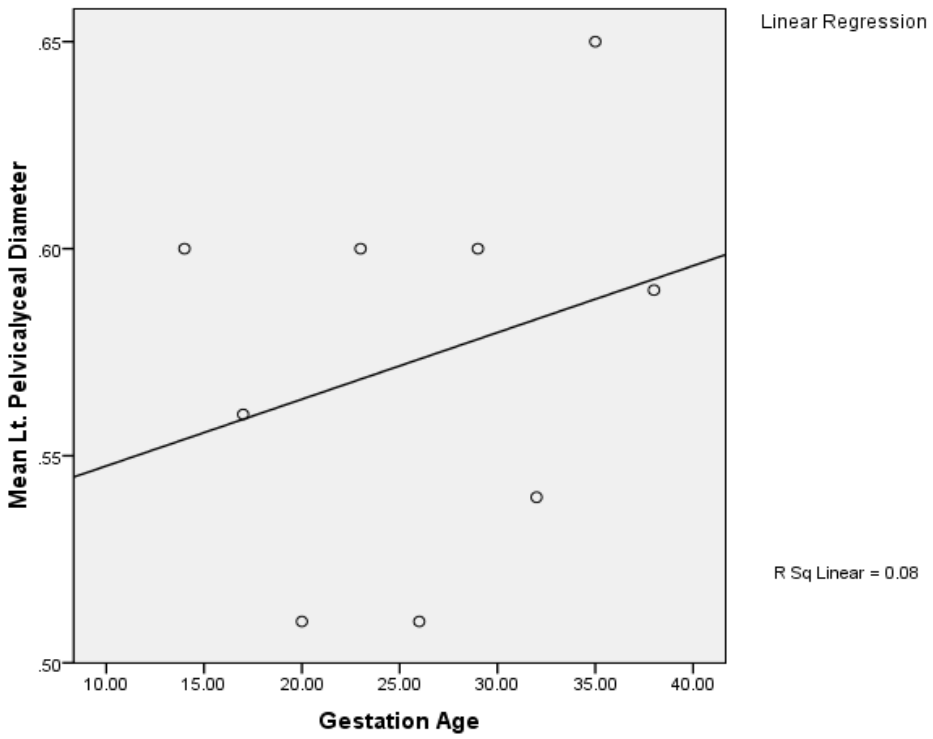

Fig. 7: Scatter plot of pelvicalyceal diameter by gestational age for the Left. Kidney.

DISCUSSION

Ultrasonography remains the modality of choice in the evaluation of hydronephrosis of pregnancy due to the fact that it is non-invasive, accessible, cheap, and does not use ionizing radiation which is detrimental to the fetus [3]. Studies have documented the ability of ultrasound to detect hydronephrosis [4]. On sonography, hydronephrosis appears as an anechoic or hypoechoic region of fluid collection that splits the white central echo of the renal sinus. it has a shape of the calyces and the renal pelvis.[3] Alternatively Schulman and his colleague [13] were able to demonstrate urinary tract dilatation in pregnancy using intravenous urography in 220 patients. In the present study, ultrasonography was used due to the reasons stated above. Isfahani *et al.*, [3] in their cross sectional study had a mean age of 25.4years whereas in the present study the mean age of the study group was 29.7years while that of the control group was 26.9years which suggests that the reproductive age of both studies is between 25 and 30 years. However there was no significant correlation between the maternal age and the incidence of hydronephrosis. Studies have reported the incidence of hydronephrosis in pregnancy to be between 60 and 100% for both kidneys with a right sided predominance [6]. Isfahani et al.[3] reported an incidence of 69.5% of 59 patients, 85.3% of whom had developed hydronephrosis on the right kidney and 41.5% on the left. Erickson *et al.*, [6] evaluated 449 pregnant patients and 39 non pregnant patients and discovered an overall incidence of 63% renal pelvic dilatation over the non-pregnant control group. In Lokoja, Nigeria, the incidence of pelvicalyceal dilatation was 93.4% on the right and 83.4% on the left. The incidence of hydronephrosis in this study was 66.3% in the right kidney and 48.9% on the left which is in agreement with the findings of the above mentioned studies. Fifty percent of pregnant women were found to have urinary system dilatation in the second and third trimesters of pregnancy in a study done by Faundes *et al.*, [14]. Three radiologists examined 100 consecutive patients presenting for gestational assessment by ultrasonography for hydronephrosis. Approximately 50% of the patients had hydronephrosis particularly in the second and third trimesters and hydronephrosis was more prevalent on the right than on the left side [15]. The findings of the present study is similar to the above mentioned studies. The right sided predominance has been attributed to the differences in the anatomical relations of the right and left ureters. In particular, it has been suggested that the relationship of the right ureter to the right iliac artery and ovarian vein at the level of the pelvic brim, accentuates the effects of compression by the gravid uterus [1]. On the other hand some studies have found hormonal factors which is the smooth muscle relaxing effect of progesterone to be contributory to the development of hydronephrosis [15]. The findings of the present study support the mechanical theory due to the right sided predominance observed. An increase in pelvicalyceal dilatation with increasing gestational age has been recorded in several studies. [8,9,10] There was positive correlation between the gestational age and the degree of dilatation of both the right kidney (r=0.174,

p=0.655) and the left kidney(r= 0.282, p=0.462). This is in agreement with the previously mentioned studies. On the contrary, Erickson *et al*[6] found maximal calyceal diameter to occur between 26 and 28 weeks. They attributed their findings to maximal compression of the gravid uterus which was wedged in the pelvis at this time, together with a competent abdominal musculature [6]. Another study observed calyceal dilatation in the right kidney to increase by 0.5mm/week up to 24-26 weeks and 0.3mm/week up to 31-32 weeks and remained stable until term. While the left maximal calyceal diameter attained 8 mm around week 20 to 24 weeks and remained stable until term [14]. Maximum calyceal diameter in the study by Erickson *et al.*, [6] reported the maximal calyceal diameter to be 1.1cm in the right kidney and 0.9cm in the left kidney (moderate calyceal dilatation) whereas in this study the maximum calyceal dilatation was 1.9cm in the right kidney and 1.6cm in the left Kidney (ie severe calyceal dilatation). The difference in the mean calyceal diameter recorded may be due to the difference in the gestational ages of the study group as calyceal diameter has been shown to increase with gestational age. Isfahani *et al,*. [3] found out that the degree of dilatation was inversely related to parity as its frequency was greater in first pregnancies. On the other hand Peake *et al.*, [8] and Schulman et al[13] did not find parity to be relevant to the degree of dilatation. Contrary to the aforementioned findings, this study found significant positive relationship between parity and the degree of dilatation of both kidneys in this study with mean pelvicalyceal diameter slightly higher in the multiparous subjects. The pattern of hydronephrosis of pregnancy observed in this study, is a gradual increase in pelvicalyceal dilatation throughout pregnancy. It is probably true to say that mechanical factors play a major role in the pathophysiology of hydronephrosis of pregnancy because the asymmetry in the degree of dilatation cannot be explained by the hormonal theory.

CONCLUSION

Hydronephrosis does occur in pregnancy and has a right sided predominance. Mild hydronephrosis is the commonest pattern seen in pregnancy. The degree of hydronephrosis in pregnancy increases with increasing gestational age and parity. Knowledge gained from this work will be useful to the gynecologist, Radiologist and the Medical Scientist.

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