Original Research Article

RELATIONSHIP BETWEEN MATERNAL HYDRONEPHROSIS AND ESTIMATED FOETAL WEIGHT IN BAYELSA STATE, SOUTH-SOUTH NIGERIA

ABSTRACT

Background: Hydronephrosis is the dilatation of the renal calyces and pelvises by urine, as a result of obstruction of the outflow of urine distal to the renal pelvis. It is a common finding in normal pregnancy, and usually physiological.

Objective: To determine the relationship between maternal hydronephrosis and estimated foetal weight in normal pregnancy.

Materials and Methods: This was a prospective study that was carried out at the Obstetric Units and Radiology Departments of the Federal Medical Centre, Yenagoa and the Niger Delta University Teaching Hospital, Okolobiri, both in Bayelsa State, Nigeria, for over six months. Sonographic evaluation of the renal pelvises and calyces of 400 normal pregnant women were performed and compared with estimated foetal weights. Relevant data were entered into a pre-designed proforma and analysed. Spearman's correlation coefficient was used to determine the relationship between maternal hydronephrosis and estimated foetal weight.

Results: Of the four hundred pregnant women enrolled in this study, about 36% had hydronephrosis (27% with Grade 1 and 9% with Grade 2). While gestational age (**ρ** = 0.22; p – 0.001) and estimated foetal weight (**ρ** = 0.26; p – 0.001) were significantly related to hydronephrosis, maternal features including maternal age (**ρ** = 0.05; p – 0.523), maternal weight (**ρ** = 0.01; p – 0.935) and parity (**ρ** = 0.06; p – 0.368) were not.

Conclusion: Our study revealed that there was a relationship between maternal hydronephrosis and estimated foetal weight in normal pregnancy. The degree of pelvicalyceal dilatation also increased with gestational age.

Keywords: Hydronephrosis, Pregnancy, Pelvis, Calyx, Dilatation, Foetal weight.

INTRODUCTION

Asymptomatic hydronephrosis occurs in 80 – 90% of pregnancies.[1,2] It is usually physiological and uncommonly pathological. In pregnancy, physiological dilatation of the renal calyces, pelvises and upper ureters usually occurs due to the compression of the ureters by the pregnant uterus, and due to the smooth muscle relaxing effect of progesterone on the renal system. Hydronephrosis is more common in the right kidney,[2–6] more in the primigravida, and usually starts in the second trimester of pregnancy. "It

resolves spontaneously six to twelve weeks after delivery. The plausible reason for hydronephrosis being more common in the right kidney may be due to the dextrorotation of the pregnant uterus to the right, leading to the compression of the right ureter, and partly sparing the left ureter.[5] Another reason is the crossing of the right ureter by the right iliac and ovarian vessels in the pelvic brim which increases the risk of pelvicalyceal dilatation".[5] The left ureter is also partly shielded from compression by the protective effect of the sigmoid colon.[5] Pathological dilatation of the renal calyces, pelvises and upper ureters occurs in 0.2 – 3% of pregnancies.[7,8]

Pregnancy is associated with many physiological changes which affect both the woman and the foetus.[9] The weight of the foetus is an important factor to consider when determining the outcome of pregnancy.[9] As the foetus grows larger, the larger the uterus becomes, and possibly the more the compression on the ureters. This may be evidenced by the more pelvicalyceal dilatation seen in patients with twin gestations and polyhydramnios.[10] This relationship between the foetus and dilatation of the renal system has not been well researched, as there is a paucity of published data on the subject matter. The objective of this study was to determine the relationship between maternal hydronephrosis and estimated foetal weight.

MATERIALS AND METHODS

This research was conducted at the Obstetric Units and Radiology Departments of the Federal Medical Centre, Yenagoa and the Niger Delta University Teaching Hospital, Okolobiri, for over six months, from July to December 2021. These are the two tertiary hospitals in Bayelsa State, Nigeria, and they offer service, training and research, and serve as referral centres for hospitals in Bayelsa State and surrounding Delta and Rivers States. This survey was a prospective, descriptive, cross-sectional study.

The sample size for this study was calculated using the formula:

$n = z^2pq/d^2$ [11]

Where:

"n = minimum sample size

z = normal standard deviation set at 95% confidence limit = 1.96

p = prevalence (63% = 0.63) of hydronephrosis from a previous study".[12]

q = 1 – p (complementary probability).

d = margin of error = 5% = 0.05

Calculation:

$n = (1.96)^2 \times 0.63 \times 0.37 / (0.05)^2$

$n = 3.8416 \times 0.63 \times 0.37 / 0.0025$

$n = 0.8955 / 0.0025$

$n = 358.2$

considering attrition = 10% of 358.2 = 35.9

therefore:

n = 358.2 + 35.9

n = 394.1

'n' was adjusted to 400

The estimated foetal weight and the dimensions of the renal pelvis and calyx were evaluated (measured) for 400 normal pregnant women in our facilities. The inclusion criteria for the study included pregnant women without any known renal or cardiovascular diseases. The exclusion criteria were women with known medical condition(s) in pregnancy or renal pathology. Eligible women for the study were recruited from the antenatal clinic and were counselled before obtaining written informed consent. They were referred to the Radiology Department for a routine obstetric ultrasound scan. A pre-designed proforma was used to document the age, parity, gestational age, and blood pressure of the women. Dipstick was used to perform urinalysis before ultrasound scan evaluation, to rule out glycosuria and proteinuria. The scans were performed for patients in different trimesters of pregnancy for comparison.

A real-time, greyscale, ultrasound examination was performed using the 2012 Philips HD11 machine, fitted with a 3.5 MHz curvilinear transducer, with electronic callipers to measure the length, width and thickness of both kidneys. In the supine position, the ultrasound foetal weight was calculated automatically by the ultrasound machine, using Hadlock's reference table, which uses the biparietal diameter, abdominal circumference and femur length.[13] The rest of the sonography was then performed in the semi-prone position in other not to put pressure on the pregnant uterus. All patients were afterwords required to empty their urinary bladder.

"The scans were performed posteriorly through the back. The real-time greyscale images were frozen following clear identification of the inferior and superior renal poles in the longitudinal plane. The renal length (L) was taken as the longest distance between the poles using an electronic calliper while the anteroposterior (AP) diameter (thickness) was measured from the anterior wall to the posterior wall of the kidney at its mid portion. The renal width (W) was measured on a transverse scan and the maximum transverse diameter was taken at the level of the hilum as the renal width. Centimetre (cm) was the unit of measurement. The renal volume was calculated using the formula, volume = length x width x breadth x 0.523."[14] The pelvicalyceal diameter was measured, and an assessment of the degree of pelvicalyceal dilatation was made and documented. To standardize the evaluations of the dimensions of the renal pelvis and calyx, only one radiologist per centre performed the ultrasound scans. The accuracy of the device used was maintained by always adjusting the 'gain' and applying adequate ultrasound gel. This helps to get the best image quality and resolution possible.

"The degree of hydronephrosis was graded with the Society for Foetal Urology (SFU) grading system[15] as follows" (Figure 1):

Grade 0

- no dilatation, calyceal walls are apposed to each other.

Grade 1 (mild)

- dilatation of the renal pelvis without dilatation of the calyces (can also occur in the extrarenal pelvis).
- no parenchymal atrophy.

Grade 2 (mild)

- dilatation of the renal pelvis (mild) and calyces (pelvicalyceal pattern is retained)
- no parenchymal atrophy.

Grade 3 (moderate)

- moderate dilatation of the renal pelvis and calyces.
- blunting of fornices and flattening of papillae.
- mild cortical thinning may be seen.

Grade 4 (severe)

- gross dilatation of the renal pelvis and calyces, which appear ballooned.
- loss of borders between the renal pelvis and calyces.
- renal atrophy is seen as cortical thinning.

In this study, Grade 0 corresponded to no dilatation; Grade 1 & 2 corresponded to mild dilatation; Grade 3 corresponded to moderate dilatation; Grade 4 corresponded to severe dilatation.

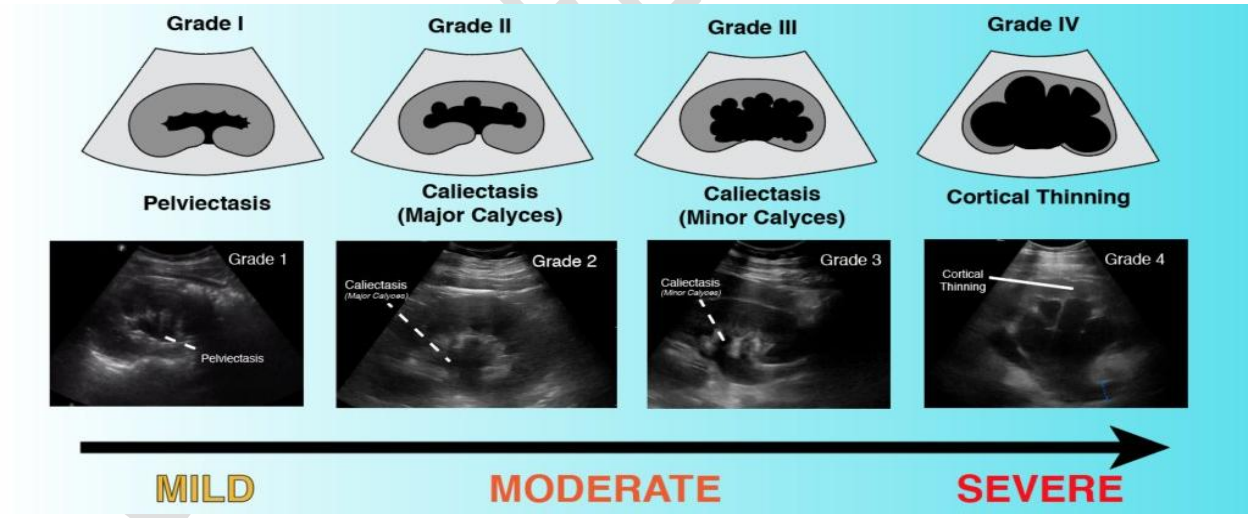

Figure 1: Diagram showing Society for Foetal Urology (SFU) grading system for hydronephrosis.[16]

Data analysis

A pre-designed proforma was used to enter the data before being analysed with the Statistical Product and Service Solutions for Windows® version 25, SPSS Inc.; Chicago, USA. Our results were presented in

frequencies and percentages (for categorical variables) and mean and standard deviation (for continuous variables). Spearman's correlation coefficient was used to determine the relationship between maternal hydronephrosis and estimated foetal weight.

RESULTS

Four hundred pregnant women participated in this study. The mean age was 28.7 ± 6.0 years (Table 1). The modal age group (30.0%) was between 25 – 29 years, while a quarter (25.0%) was aged 30 – 34 years. Most (39.0%) of the women were nulliparous and in the second trimester (56.0%) of pregnancy. About 36.0% had hydronephrosis (27.0% with Grade 1 and 9.0% with Grade 2) (Table 1). The mean maternal weight was 70.6 ± 13.6 years and the mean estimated foetal weight was 1.6 ± 0.9kg (Table 1).

While gestational age (ρ = 0.22; p – 0.001) and estimated foetal weight (ρ = 0.26; p – 0.001) were significantly related with hydronephrosis, maternal features including maternal age (ρ = 0.22; p – 0.001), maternal weight (ρ = 0.22; p – 0.001) and parity (ρ = 0.22; p – 0.001) were not related significantly (Table 2). The gestational age (*F* = 5.25; p – 0.006) and estimated foetal weight (*F* = 5.79; p – 0.004) were significantly higher among women with Grade 1 and Grade 2 hydronephrosis than those without hydronephrosis (Table 3; Figure 2). However, maternal age, maternal weight and parity did not show a significant difference between the study groups (Table 3). Figure 2 shows normal right and left pelvicalyceal systems.

Table 1: Maternal and foetal features

Characteristics	Frequency N = 400	Percent (%)
Maternal age (years)		
> 20	28	7.0
20 – 24	76	19.0
25 – 29	120	30.0
30 – 34	100	25.0
> 35	76	19.0
Mean maternal age ± SD in years	28.7 ± 6.0	
Parity		
Nulliparous (0)	156	39.0
Primiparous (1)	92	23.0
Multiparous (2 – 4)	132	33.0
Grand-multiparous (≥ 5)	20	5.0
Median parity (range)	1 (0 – 6)	
Trimester of pregnancy		
First	28	7.0
Second	224	56.0
Third	148	37.0
Mean gestational age ± SD (in weeks)	25.9 ± 6.8	
Grade of hydronephrosis (calyceal dilatation)		
None	256	64.0
Grade 1	108	27.0
Grade 2	36	9.0

Maternal weight ± SD (kg)	70.6 ± 13.6
Estimated foetal weight ± SD (kg)	1.6 ± 0.9

Table 2: Relationship between hydronephrosis and maternal/foetal variables

Variables	rho (p-Value)
Grade of hydronephrosis and maternal age (years)	0.05 (0.523)
Grade of hydronephrosis and maternal weight (kg)	0.01 (0.935)
Grade of hydronephrosis and gestational age (weeks)	0.22 (0.001*)
Grade of hydronephrosis and estimated foetal weight (kg)	0.26 (0.001*)
Grade of hydronephrosis and parity	0.06 (0.368)

rho – Spearman's correlation coefficient.
*Statistically significant

Table 3: Comparison of maternal and foetal characteristics

Variables	No dilatation n = 256 (64.0%)	Grade 1 n = 108 (27.0%)	Grade 2 n = 36 (9.0%)	F-statistics (p-Value)
Maternal age (years)	28.59 ± 6.41	28.33 ± 5.41	30.66 ± 4.97	1.07 (0.344)
Maternal weight (kg)	70.75 ± 13.00	69.29 ± 15.00	74.44 ± 12.77	0.98 (0.378)
Gestational age (weeks)	24.87 ± 6.70	27.70 ± 6.48	28.55 ± 6.68	5.25 (0.006*)
Estimated foetal weight (kg)	0.88 ± 1.10	1.33 ± 1.11	1.68 ± 1.37	5.79 (0.004*)
Parity	1 (0 – 6)	1 (0 – 4)	2 (0 – 6)	3.94 (0.139)

*Statistically significant

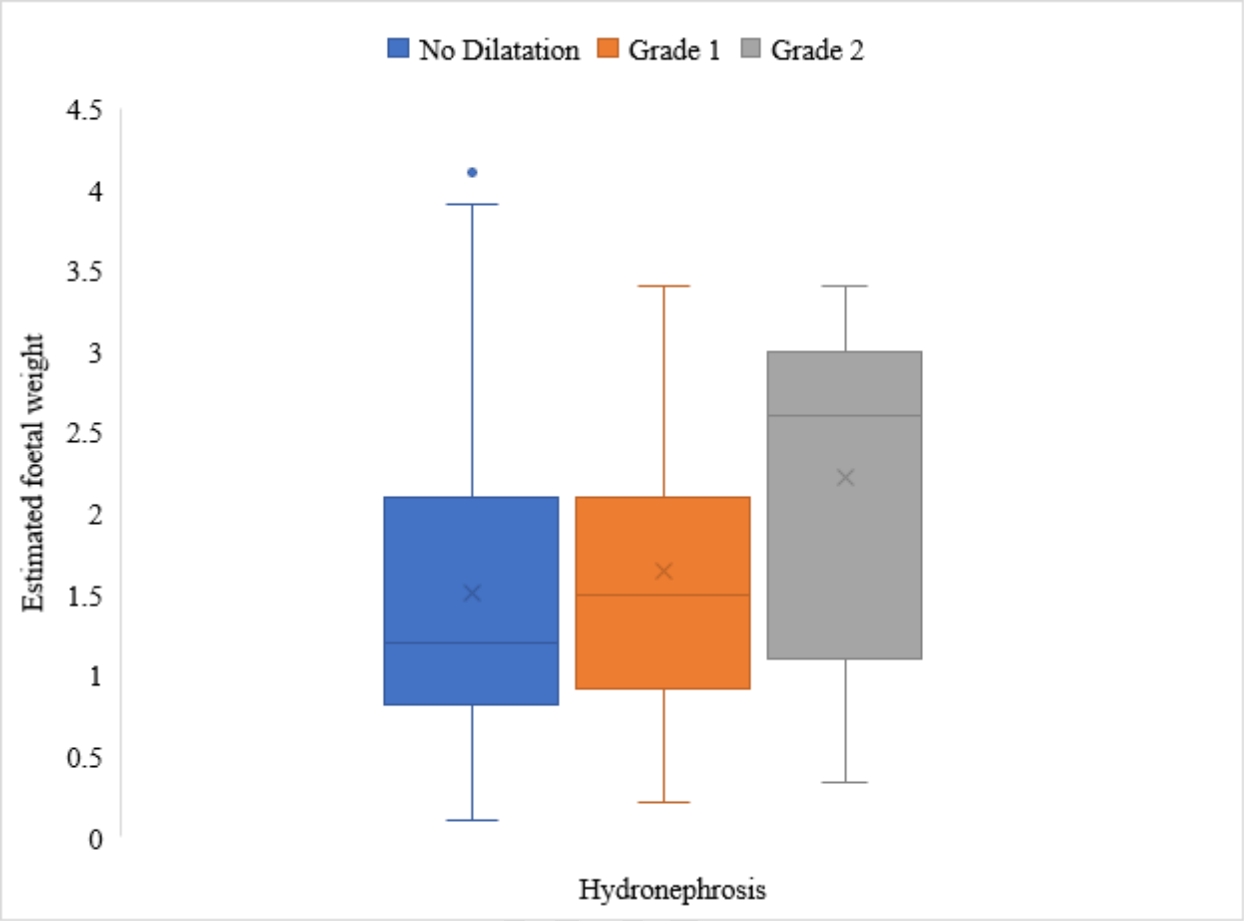

Figure 2: Estimated foetal weight and maternal hydronephrosis

DISCUSSION

Hydronephrosis is known to occur in pregnancy, and is predominantly asymptomatic in about 9 out of 10 pregnancies.[1,2,5] This study, is in agreement with the literature, as study participants had no symptoms suggestive of a renal compromise warranting any medical or surgical intervention. This, albeit, was in contrast to reports from various studies which reported findings of symptomatic hydronephrosis that ranged from 0.5% to 4.7%, [7,15–17]. These studies demonstrated that a considerable proportion of pregnant women with symptomatic hydronephrosis had a coexisting urinary tract infection. Puskar et al,[7] and Rasmussen et al,[4] suggested that the dilatation of the ureter (which can hold up to about 300 ml of urine) leading to stasis is likely responsible for the increased tendency of asymptomatic bacteriuria to progress to symptomatic infection during pregnancy. Other authors have also reported reasons such as increased diuresis,[18] presence of calculi and 'factors unrecognised',[7,8] to be responsible for decompensation of ureteral function, leading to symptomatic hydronephrosis. Our study, therefore, highlights the rarity of the occurrence of symptomatic hydronephrosis in pregnancy.

It was also interesting to note that none of the women in our cohort had grade 3 hydronephrosis. The physiological changes in the kidneys during pregnancy that lead to hydronephrosis arises from the dilatation of the renal pelvicalyceal system that results mainly from the direct external compressive force exerted on the ureter by the uterus and to a lesser extent, the physiologic effect progesterone has on smooth muscles of the ureter. These changes occur almost exclusively in all women that develop hydronephrosis. The finding of lower grades of hydronephrosis was in contrast to other studies,[16,17], where authors found different grades of hydronephrosis. We propose that since the normal physiological changes in pregnancy resulting in hydronephrosis occur in 43% to 100%[19] of pregnancies and our cohort had a preponderance of no hydronephrosis and grade I – our findings can be considered to be essentially normal.

We included only singleton pregnancies to enable us to appreciate the fact that uterine size only changed as a consequence of foetal growth. Our study demonstrated a positive correlation between estimated foetal weight and the grade of hydronephrosis and the difference in estimated foetal weight was statistically significant when compared to the severity of hydronephrosis. This is in keeping with what has been previously reported in other studies by Bayraktar et al. and Coban et al., in Turkey.[16,17]

Consistent with the literature,[5,16,17,20] we found that hydronephrosis was diagnosed in the second trimester. We observed ultrasound changes between the 27th and 28th week of gestation and dilatation of the right kidney was more common than the left in our cohort. We also report that as calyceal dilatation worsened, there was a corresponding increase in gestational age. Our findings are similar to reports from other studies.[16,17] Overall, our findings suggest that pregnancy-induced hydronephrosis is physiological and its severity is in tandem with increasing foetal size and increasing gestational age. Hence, clinically, our findings are of importance, because it highlights the fact that the renal complication of hydronephrosis seen in pregnancy is related to the physiological changes of the maternal body and the presence of the foetus. More importantly, this complication will resolve spontaneously after birth.[19]

Our study's strength lies in the fact that it is the first study that has assessed the relationship between maternal hydronephrosis and estimated foetal weight in our region. This study is limited in that, mothers were not followed up longitudinally. It would have been worth studying further if gestational age and actual foetal weight may have influenced the lower grades of hydronephrosis observed in this study by conducting larger multi-centered cohort studies in this setting.

CONCLUSION

Our study revealed that there was a relationship between maternal hydronephrosis and estimated foetal weight in normal pregnancy. The degree of pelvicalyceal dilatation also increased with gestational age.

ETHICAL APPROVAL

This prospective, descriptive, cross-sectional study was examined and approved by the Research and Ethics Committees of the hospitals.

Consent

Eligible women for the study were recruited from the antenatal clinic and were counselled before obtaining written informed consent.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The anonymized data used for this research were obtained in the course of this research and in the country of the participants. There is absolutely no conflict of interest between the authors and findings of this research are only for the advancement of knowledge. The research was funded by personal efforts of the authors.

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