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Measurable Changes in Hydronephrosis During Pregnancy Induced by Positional Changes: Ultrasonic Assessment and its Diagnostic Implication

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ABSTRACT

Introduction: Unilateral or bilateral dilation of the ureters occurs commonly during pregnancy. Ultrasonography is a suitable diagnostic method in hydronephrosis; however, it cannot differentiate obstructive from nonobstructive hydronephrosis. Our aim was to evaluate measurable changes in hydronephrosis induced by a mother's positional changes using ultrasonography to differentiate hydronephrosis during pregnancy from pathologic etiologies.

Materials and Methods: Pregnant women presenting for routine ultrasonography were enrolled in this study. History taking, and physical examination were done. Ultrasonography was performed to determine gestational age, parity, fetal presentation, presence or absence of hydramnios, and hydronephrosis and its severity. Thirty minutes after changing position (flank position or on all fours), patients were reevaluated by ultrasonography to determine the severity of hydronephrosis.

Results: Of 59 pregnant women with an average age of 25.4 years, 33 (55.9%) had no urinary complaint during pregnancy. Forty-one women (69.5%) had hydronephrosis, 24 (58.5%) of whom only in right kidney. The severity of hydronephrosis in one kidney was related with the severity of hydronephrosis in the other kidney (P = 0.007). Fetal presentation and gestational age were not associated with hydronephrosis. Risk of hydronephrosis was higher in the first pregnancy (likelihood ratio = 6.8, P = 0.009). Thirty minutes after changing positions, the anteroposterior pelvis diameter significantly decreased in the right and left kidneys (P = 0.004, P = 0.001).

Conclusion: Ultraonography in two steps with positional change (dynamic ultrasonography) may be used to differentiate hydronephrosis of pregnancy from other pathologies.

KEY WORDS: hydronephrosis, pregnancy, ultrasonography, diagnosis

Introduction

One hundred and fifty years ago, Cruveilhier noted that pregnancy can induce obstruction of the upper urinary tract. Imaging studies including intravenous pyelography and ultrasonography have shown that dilation of the upper urinary tract develops in most pregnant women.[1,2] One study from Italy has demonstrated that asymptomatic, unilateral or bilateral hydronephrosis during pregnancy can be

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seen in 80% to 90% of pregnant women in the third trimester, with the right side being the most frequently affected side.[3] Mechanical pressure of an enlarged uterus is presumed to be the main cause of hydronephrosis and stasis during pregnancy. Acute renal failure during pregnancy due to ureteral obstruction in patients with a single kidney has been reported [4], although acute renal failure due to bilateral obstruction is rare.[5] Although obstruction is regarded as the main cause of hydronephrosis, several researchers also have emphasized the role of progesterone and gonadotropins in ureteral stasis and its subsequent complications in pregnancy.[6,7]

Physiologic changes during pregnancy may obscure the manifestations of ureteral obstruction. Nausea, vomiting, back pain, urinary frequency, and dysuria could be symptoms of ureteral obstruction or of the pregnancy itself. A definite diagnosis based on these symptoms, and their association with hydronephrosis during pregnancy, is a pivotal challenge to urologists. The progression of signs or localization of flank pain suggests non–pregnancy-induced ureteral obstruction; particularly, if it is associated with fever or urinary tract infection.[8 p422-3] However, more precise paraclinical assessment is needed. Since exposure to 1 rad of x-ray leads to a 2.4-fold increased risk of developing malignancies in infants, it would seem prudent to avoid radiographic assessment.[9] Furthermore, radiographs can increase the risk of fetal anomalies in the first and second trimesters of pregnancy.

In the clinic, ultrasonography is considered of the imaging modality of choice to evaluate the kidney.[10] Accordingly, we studied ultrasonic methods, and hereby present a simple and innovative method of using ultrasonography to differentiate hydronephrosis during pregnancy from hydronephrosis caused by ureteral obstruction due to nonpregnancy pathologies such as stone, tumor, and others.

Materials and Methods

In a cross-sectional study, we evaluated the ultrasonographic results of consecutive pregnant women with various ages, parity, and gestational ages who had been referred to Hajar Hospital in Shahrekord, Iran, for routine follow-up. History was taken regarding frequency, dysuria, flank pain, past history, and previous surgery. Ultrasonography was performed, and fetal age, number of fetuses, presentation of fetus, and presence of hydramnios were assessed by a single radiologist. The presence of hydronephrosis and its severity in the left and right kidney were evaluated separately. Hydronephrosis of the pelvis with a maximal diameter of less than 15 mm was regarded as mild. A maximal diameter between 15 mm and 20 mm was defined as moderate, and maximal diameters greater than 20 mm were considered severe. Patients with hydronephrosis were positioned for 20 to 30 minutes in such a way that the uterus and fetus were away from the hydronephrosis side (they were asked to lie on the opposite side of the hydronephrosis or to bend over on their hands and knees). Then, ultrasonography was performed from the unit with hydronephrosis in this position to detect any changes in hydronephrosis, pelvis, and calyx sizes.

SPSS software (Statistical Package for the Social Sciences, version 9.05, SSPS Inc, Chicago, Ill, USA) was used for statistical analyses. Measured sizes before and after positional changes were compared using a paired t test. Analyses of the data regarding the frequency and severity of left-side and right-sided hydronephrosis, fetal presentation, parity, mother's age, and gestational age were done with a chi-square test.

Results

Of 59 pregnant women with a mean age of 25.4 years (range, 17 to 38 years), 41 (69.5%) had unilateral or bilateral hydronephrosis. Thirty-three patients (56%) had no urinary complaint during pregnancy. Of the 41 patients with hydronephrosis, 16 (39%) had flank pain, 11 (26.8%) had dysuria and frequency, and 2 (4.9%) had incontinence. Unilateral right-side hydronephrosis was present in 24 (58.5%) patients with hydronephrosis, while 6 (14.6%) patients had unilateral left-sided hydronephrosis (Table 1).

The severity of hydronephrosis in one kidney was related with the severity in the other kidney (P = 0.007). Forty of 58 pregnant women had fetuses with cephalic presentation, 30 (75%) of whom developed hydronephrosis; 18 had fetuses with a breech presentation, 10 (55.6%) of which developed hydronephrosis (P = 0.13).

Twenty-two of 25 (88%) women with no previous delivery, 13 of 25 (52%) with 1 previous

TABLE 1. *Frequency of hydronephrosis and the classification according to its severity in the right and left kidneys. The prevalence and severity of hydronephrosis was higher in the right kidney than in the left one. The severity of hydronephrosis in the units was related (P = 0.007).*

Number (%)		Severity of hydronephrosis in the right kidney				Total
		No	Mild	Moderate	Severe	
Severity of hydronephrosis in the left kidney	No	0 (0.0)	17 (41.5)	6 (14.6)	1 (2.4)	24 (58.5)
	Mild	6 (14.6)	2 (4.9)	6 (14.6)	1 (2.4)	15 (4.9)
	Moderate	0 (0.0)	1 (2.4)	1(2.4)	0 (0.0)	0 (0.0)
	Severe	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Total	6 (14.6)	20 (48.8)	13 (31.7)	2 (4.8)	41 (100)

delivery, and 6 of 8 (75%) with more than 1 previous deliveries had hydronephrosis. Accordingly, the likelihood ratio of hydronephrosis in the first pregnancy compared with that of subsequent pregnancies was 6.8 (P = 0.009). However, there was no association of parity with the severity of hydronephrosis. Of 23 patients under 25 years old, 18 had hydronephrosis; of 17 with the age range of 25 to 30 years, 11 had hydronephrosis; and of 17 patients older than 30 years, 10 had hydronephrosis. Prevalence and severity of hydronephrosis were not significantly related with maternal age. Table 2 shows the frequencies of hydronephrosis in the subgroups of different gestational ages. Gestational age was not associated with hydronephrosis (P = 0.54).

Table 3 shows the anteroposterior diameters of the pelvis and changes in its ultrasonic measurements before and 30 minutes after positional change in the left and right kidneys. A significant decrease was found in the right and the left kidneys 30 minutes after changing the patient's position (P = 0.004, P = 0.001).

TABLE 2. *The frequency of hydronephrosis at different gestational weeks. There were no statistically significant relationships between hydronephrosis and gestational week (P = 0.54).*

Number (%)	Less than 25 weeks	Between 25 and 30 weeks	More than 30 weeks	Total
No hydronephrosis	4 (44.4)	10 (33.3)	4 (23.5)	18
Hydronephrosis	5 (55.6)	20 (66.7)	13 (76.5)	38
Total	9 (100)	30 (100)	17 (100)	56

Discussion

In many clinical situations, ultrasonography remains the modality of choice for evaluation of the kidney.[10] This is an inexpensive and readily available diagnostic instrument for use in at-risk patients whose kidneys should be regularly monitored. Ultrasonography is the first diagnostic step in evaluating kidneys in patients with azotemia, those who are sensitive to contrast media, pregnant women, and children. However, false negative and false positive results for hydronephrosis are possible. 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 renal pelvis (pyelocaliectasis). Since ultrasonography cannot assess the function of the kidneys, we are not able to distinguish obstructive from nonobstructive hydronephrosis. Some authors have attempted to diagnose acute and chronic obstructions by measuring the resistive index of the intrarenal arteries.[8 p134,11,12]

The diagnostic value of ultrasonography in pregnant patients may be enhanced by distinguishing hydronephrosis during pregnancy from other ureteral obstruction pathologies (eg, by monitoring the increase in hydronephrosis during pregnancy, defining the normal sizes of hydronephrosis at different gestational weeks,[13] or studying the ureteral jet by color Doppler ultrasonography in normal pregnancy and in pathologic obstruction[14]).

The purpose of this survey was to explore the accuracy of ultrasonography for differentiating

TABLE 3. *The size (mean ± standard deviation) of the anteroposterior diameter of the pelvis and its changes before and after positional change (mm) in patients with hydronephrosis.*

Anteroposterior diameter of the pelvis (mm)	Number of patients	Before positional change	After positional change	Difference	*P* value
Right-side hydronephrosis	36	15.4 ± 3.6	10.8 ± 3.8	4.7 ± 2.5	0.004
Left-side hydronephrosis	17	12.8 ± 1.7	8.5 ± 3.4	3.4 ± 2.6	0.001

hydronephrosis during pregnancy from other pathologies. By changing patient position, we were able to measure any positive or negative changes in hydronephrosis severity. Hydronephrosis was observed in 69.5% of 59 patients, 85.3% of whom had developed hydronephrosis in the right kidney and 41.5% in the left. In 1998, Faundes and colleagues performed serial ultrasonography in 1506 pregnant women and in 181 women after delivery. They found that 50% of pregnant women had urinary system dilation during the second and third trimesters of pregnancy.[13] In 1979, Erickson and coworkers noted that 60% to 65% of 449 pregnant women presented with hydronephrosis.[15] Another study showed that hydronephrosis developed on the right side in 90% of patients and in the left in 67%.[16] Thus, our results were similar to those of the mentioned studies. Since left and right hydronephrosis have a common etiology in pregnancy, it is probable that the severity of hydronephrosis in one kidney is related to that of the other, as indicated in Table 1.

Our study showed that pressure of the fetus's head on the pelvis in those with cephalic presentation could be an additional factor in hydronephrosis during pregnancy. However, the difference in the rate of hydronephrosis in cephalic presentation compared with breech presentation (75% vs 55.6%), was not statistically significant. Further studies are recommended to determine the relationship between fetal presentation and hydronephrosis during pregnancy.

In this study, hydronephrosis during pregnancy was inversely related with parity, as its frequency was higher in first pregnancies. This is in agreement with other studies.[8 p422-3] However, some researchers have not confirmed this finding.[3,16]

In some studies, the incidence of hydronephrosis has been shown to increase with gestational age, which may be the result of fetal growth (ie, an increase in uterus size and pressure on the ureters). Erickson and colleagues have reported an increase in the severity of hydronephrosis from the 21st week up to the 30th gestational week in 449 pregnant women. They have shown that the degree of hydronephrosis remains stable for the next 10 weeks.[15] However, the incidence of hydronephrosis in our patients was not associated with this factor (Table 2).

No multiple pregnancy or hydramnios was found in this study, so that we could not evaluate the severity of hydronephrosis in these conditions.

In 1979, Roberts[17] emphasized some findings in this regard, some of which have been shown in other studies:

1. An increase in the basal pressure of the ureters and obstructive changes over the pelvic brim occur in pregnancy. The resultant pressure decreases with positional changes, by which the uterus is kept away from the ureter.[18]
2. It has been reported that the contraction of a normal ureter is preserved during pregnancy, which contrasts the hypothesis of ureteral dilation in pregnancy as a result of atony caused by hormonal factors.
3. Hydronephrosis during pregnancy does not develop in those whose ureter does not pass by the pelvic margin (such as those with pelvic kidney or ileal conduit).
4. Hydronephrosis during pregnancy does not occur in animals whose ureters are not adjacent to the uterus, as they stand on all fours.[19]
5. In pregnant monkeys, when the uterine pressure is removed from ureter during laparotomy or when the fetus and placenta are removed from uterus, the ureteral pressure returns to normal levels.

Regarding the above-mentioned findings, it seems reasonable to observe a significant decrease in the anteroposterior diameter of pelvis when comparing the measurements before and 30 minutes after positional changes in ultrasonography.

Conclusion

Positional changes in pregnant women with hydronephrosis can alter the severity of mechanical obstruction caused by the enlarged uterus. Thus, comparing the measurements of the pelvis with ultrasonography before and after a positional change (during which the uterus moves away from the ureters). While acknowledging the limitations of this study and the need for further investigation, we can conclude that the size of the anteroposterior diameter of the pelvis (and calices to a lesser extent) in different positions could be helpful in the differential diagnosis of hydronephrosis of pregnancy and other pathologies.

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