

An Interesting Relationship Between Maternal Adipose Tissue Thickness and Maternal Pelvicalyceal System Dilatation

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Purpose: To evaluate whether maternal body mass index (BMI), visceral adipose tissue (VAT) thickness, and subcutaneous adipose tissue (SAT) thickness have effects on maternal pelvicalyceal system dilatation, which develops during pregnancy.

Materials and Methods: Between April 2018 and November 2018, a total of 120 pregnant women aged between 18-35 years in their third trimester were included in this prospective observational study. For each pregnant woman, SAT and VAT thicknesses were measured and renal sonography was performed by the same radiologist and obstetric ultrasound was performed by the same obstetrician. Nine patients were excluded from the study because their maximal caliceal diameters were less than 5 mm. Ultimately, 111 patients were divided into three groups according to the maximal calyceal diameter (MCD).

Results: Asymptomatic hydronephrosis was diagnosed in 108/111 (97.3%) of the patients. There were 53 patients in group 1 (MCD of 5-10 mm), 39 patients in group 2 (MCD of 10-15 mm), and 19 patients in group 3 (MCD of >15 mm). There were statistically significant differences in terms of maternal SAT and VAT thickness between the groups ($P = .001$). There were also statistically significant differences between the groups for the estimated fetal weight and birth weight ($P = .024$, $P = .003$, respectively). In the correlation analysis, there was a negative correlation between maternal SAT thickness, VAT thicknesses, BMI, and maximal calyceal diameter ($P = .001$).

Conclusion: In this study, relationships between maternal BMI, VAS thickness, SAT thickness, the estimated fetal weight, birth weight, and renal pelvicalyceal dilatation have been shown. Increasing maternal adipose tissue may have a protective effect of mechanical pressure of growing uterus on the ureters.

Keywords: adipose; body mass index; hydronephrosis; pelvicalyceal system; pregnancy

INTRODUCTION

During pregnancy, many anatomic and physiologic changes occur in the urinary system. The occurrence of asymptomatic hydronephrosis has been termed physiological and it is seen in more than 90% of pregnancies⁽¹⁾. However, hydronephrosis manifested by acute pain, refractory sepsis or even renal failure has been reported⁽²⁻⁶⁾. It usually occurs after mid-pregnancy⁽⁷⁾. Acceptable explanations for pregnancy-induced dilatation are a mechanical compression of the gravid uterus on the ureters and smooth muscles relaxing the influence of progesterone^(1,7,8). It is frequently more pronounced on the right than on the left kidney and rarely occurs bilaterally^(7,9). The predisposition for the right side may be explained by the dextrorotation of the uterus and the protection of the left ureter provided by the sigmoid colon⁽¹⁰⁾. It is notified that pelvicalyceal dilatation during pregnancy correlates with polyhydramnios and the estimated fetal weight at that moment⁽¹⁰⁾. These findings suggest that pelvicalyceal dilatation may result from gravid uterus mechanical compression. Pregnancy-induced pelvicalyceal dilatation also occurs in the second half of gestation, which supports this hypothe-

sis. Growing uterus causes stasis in the urinary tract and stasis occurs as symptomatic or asymptomatic hydronephrosis in clinical terms.

Although it is known that estimated fetal weight is an etiologic factor for maternal pelvicalyceal dilatation, there are no data in the literature about maternal weight, body mass index (BMI) and maternal adipose tissue thicknesses. Accordingly, the aim of this study was to evaluate whether maternal BMI, visceral adipose tissue (VAT) thickness and subcutaneous adipose tissue (SAT) thickness have effects on pelvicaliectasis, which develops during pregnancy in the maternal pelvicalyceal system.

METHODS

This observational study was conducted at Mugla Sitki Kocman University, Department of Obstetrics and Radiology, from April 2018 to November 2018. During this period, 120 singleton pregnancies were prospectively analyzed in the third trimester of their pregnancies. The exclusion criteria were as follows: multiple pregnancies, oligohydramnios, polyhydramnios, congenital urinary anomalies of pregnant women, a history

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Table 1. Baseline characteristics of patients in groups.

	Group 1 (n=53)	Group 2 (n=39)	Group 3 (n=19)	P-value
Age (year)*	29.64 ± 4.8	27.71 ± 4.7	27.00 ± 4.66	.055
Gestational age (week)*	34.66 ± 3.3	34.44 ± 3.2	34.32 ± 3.00	.282
Gravida**	1-4	1-4	1-4	.651
Parity**	0-2	0-2	0-2	.360

*: Values are given by mean ± standard deviation

**: Values are given by minimum-maximum

$p < 0.05$ was considered as statistically significant.

One way ANOVA test was used to compare groups.

of maternal urological surgery, and any history of renal or ureteral stones, pregnancies involving girls below the age of 18 years and women over the age of 40 years.

Age at admission, gestational week, gravity, parity, side and degree of dilatation, and maternal weight and height were recorded by the obstetrician. BMI was calculated as weight divided by height squared. Obstetric sonography and biometry were also performed by the same obstetrician (SBK), using a GE Voluson pro 730 (General Electric Healthcare, Little Chalfont, UK), with a 2-9 MHz probe. Estimated fetal weight was recorded according to obstetric sonography. After delivery, the weight of the newborns was evaluated and recorded.

For each pregnant woman, SAT and VAT thicknesses were measured and renal sonography was performed by a single researcher, who had 10 years' experience (FDE), on the same day as the obstetric ultrasound using a Toshiba Aplio 500 (Toshiba Medical System Corporation, Tokyo, Japan). Renal ultrasound was performed to evaluate the status of the calyces and renal pelvis, bilaterally. The side of the greater dilatation was taken into account. Hydronephrosis was graded according to the maximal calyceal diameter (MCD), as detailed by Zwergel et al.⁽¹¹⁾

Patients were divided into three groups:

-Group 1 (grade 1); patients with MCD of 5-10 mm

-Group 2 (grade 2); patients with MCD of 10-15 mm

-Group 3 (grade 3); patients with MCD of >15 mm

After the renal ultrasound, maternal VAT thickness was quantified using ultrasound twice with the pregnant woman lying in the supine position. A convex transducer (3-8 MHz) was placed on the right side of the umbilicus at the same level of the umbilicus and from a distance of 3 cm to the umbilicus. The VAT was measured at the median line extending from the linea alba to the lumbar vertebra corpus. Maternal SAT thickness was measured at the same point as VAT thickness using a linear probe operated at 7-12 MHz. The measurements

of SAT thickness were made at a vertical distance from the skin to the linea alba in the transverse position. SAT thickness was assessed twice and an image was captured during the expiratory phase of quiet respiration without any pressure applied to fat tissue. For both VAT and SAT thicknesses, the average of the two measurements was calculated.

The primary outcome was the relationship between maternal VAT thickness and the maternal pelvicalyceal diameter. The secondary outcomes were the relationships between maternal SAT thickness, BMI, estimated fetal weight, fetal birth weight, and the maternal pelvicalyceal diameter.

The study was designed and conducted in accordance with the Helsinki Declaration. The aims of the study were explained to the patients. Written informed consent was obtained from all participants. Ethical approval was granted by the local Ethics Committee.

The SPSS 17.0 for Windows package program was used (SPSS Inc., IL, USA) for statistical analyses. The mean and standard deviation (SD) values of the parameters were used to describe scale variables. One-way analysis of variance (ANOVA) was used to compare the groups. Pearson's correlation test was used for determining correlations between the variables. Multiple regression analysis was also used. In the multiple regression model, there were one dependent and more than one independent variables. The mathematical relationship of the dependent and independent variables were investigated. A P value $< .05$ was considered statistically significant.

RESULTS

A total of 120 patients were included in the study. After measurement of the maximal calyceal diameter, nine patients were excluded from the study because the maximal calyceal diameters were less than 5 mm. Ultimately, a total of 111 pregnant women who were diagnosed as having hydronephrosis were included in

Table 2. Comparison of study outcomes between groups

	Group 1 (n = 53)	Group 2 (n = 39)	Group 3 (n = 19)	P-value
Maternal weight (kg)*	75.66 ± 12.11	73.84 ± 14.23	65.79 ± 9.7	.001
Maternal BMI (kg/m ²)*	29.61 ± 3.9	27.67 ± 4.0	25.01 ± 3.5	.001
Maternal subcutaneous adipose tissue thickness (mm)*	14.22 ± 4.4	10.24 ± 3.0	9.00 ± 2.7	.001
Maternal visceral adipose tissue thickness (mm)*	12.92 ± 4.2	9.11 ± 3.0	7.76 ± 2.6	.001
Estimated fetal weight (gr)*	2390.84 ± 686.2	2616 ± 693.3	2934.36 ± 773.94	.024
Birth weight (gr)*	3022.82 ± 409.2	3189.30 ± 429.0	3442.36 ± 498.9	.003

*: Values are given by mean ± standard deviation

Abbreviations: kg: kilogram; gr: gram; mm: millimeter; m: meter; BMI: Body mass index

$p < 0.05$ was considered as statistically significant.

One way ANOVA test was used to compare groups.

Table 3. Correlation between maximal calyceal diameter and maternal subcutaneous adipose tissue thickness, visceral adipose tissue thickness, BMI

	Maximal calyceal diameter	
	r	P-value
Maternal subcutaneous adipose tissue thickness	-.462	.001
Maternal visceral adipose tissue thickness	-.466	.001
BMI	-.264	.005

Abbreviations: BMI: Body mass index
 $p < 0.05$ was considered as statistically significant.
 Pearson correlation analysis was used.

the study. Asymptomatic hydronephrosis of pregnancy was diagnosed in 108/111 (97.3%) of the pregnant women in our institution during this period. Hydronephrosis was symptomatic in a total of 3 patients, and was treated with conservative management; each had severe right-side pain, which was treated with analgesia (Hiosin-N-butylbromur 20 mg/mL, Buscopan®, Zentiva, Istanbul) and intravenous fluids (3 liters/day). All patients included in the study had greater hydronephrosis on the right side than on the left side. The remaining 111 patients were divided into three groups due to hydronephrosis type. There were 53 patients (47.7%) in group 1, 39 patients (35.1%) in group 2, and 19 patients (17.2%) in group 3. The mean demographic and clinical data for the patients are summarized in **Table 1**. Age, gravida, gestational age, and parity were not statistically different between the groups (**Table 1**).

It was found that there was a statistically significant positive correlation between maternal SAT thickness and BMI ($r: 0.463, P = .001$). There was also a statistically significant positive correlation between maternal VAT thickness and BMI ($r: 0.453, P = .001$).

Maternal weight, BMI, and the maternal SAT and VAT thickness results of the groups are presented in **Table 2**. The BMI values were statistically significantly different between the groups ($P = .001$). The results of mater-

nal SAT and VAT thicknesses are also shown in **Table 2**. The maximal maternal SAT thickness was found as 14.22 ± 4.4 mm in group 1. There were statistically significant differences in terms of maternal SAT and VAT thickness between the groups ($P = 0.001$). Statistically significant differences were found between the study groups for the estimated fetal weight and birth weight. **Table 3** depicts the correlation between maternal SAT and VAT thicknesses, BMI, and maximal calyceal diameter. There was a negative correlation between maternal SAT and VAT thicknesses, BMI, and maximal calyceal diameter ($P = .001$). There was also a statistically significant positive correlation between VAT and SAT (**Table 4**).

Multiple regression model was performed between pelvicalyceal dilatation and other independent variables without VAT and SAT (estimated fetal weight, birth weight, maternal weight, and BMI). This regression model was statistically significant ($P = 0.005, r = 0.359$). According to this model, BMI was found to be a predictor for maternal pelvicalyceal dilatation. Then, a new multiple regression analysis was performed by adding VAT and SAT thicknesses. This new regression model was also statistically significant ($P < 0.001, r = 0.533$). According to this new model, only the SAT was found as a predictor for maternal pelvicalyceal dilatation.

Ten patients were treated with antibiotics because of urinary tract infection. Of these, five patients had grade 2 hydronephrosis and five had grade 3 hydronephrosis. The urine cultures of these patients all revealed *Escherichia coli* infection. These 10 patients were re-evaluated after antibiotic treatment and no changes were found in calyceal diameter after the treatment.

In our study, one patient (0.9%) delivered before the 37th week of the pregnancy period (35th week and 2 days). Intrauterine growth restriction was not observed in any of the patients. Ninety-eight patients were re-evaluated one month after delivery and pelvicalyceal system dilatation had disappeared in this second examination. Thirteen patients did not attend the follow-up examination; therefore, we could not re-evaluate the post-pregnancy recovery of calyceal dilatation in these patients.

DISCUSSION

With this study, it is shown for the first time in the literature that increasing BMI and SAT and VAT thicknesses may have a protective effect against developing the pelvicalyceal system dilatation in pregnant women. Also, a relationship between maternal weight, estimated fetal weight, birth weight, and renal pelvicalyceal dilatation has been shown. It is also initially shown in our study with regression models that BMI and SAT were the predictor factors of maternal pelvicalyceal dilatation occurrence. In recent years, there have been a very limited number of publications on maternal pelvicalyceal system dilatation, which is a very common physiologic change of pregnancy. Asymptomatic hydronephrosis is seen at 90% in pregnancies, whereas symptomatic hydronephrosis is seen at a rate of 0.2-3%^(7,12). In line with the literature, in our study, 3 patients were symptomatic (2.7%) and 97.3% of the patients were asymptomatic. In our practice, it was determined that slim pregnant women were more prone to hydronephrosis. The pathogenesis of maternal hydronephrosis is still not exactly

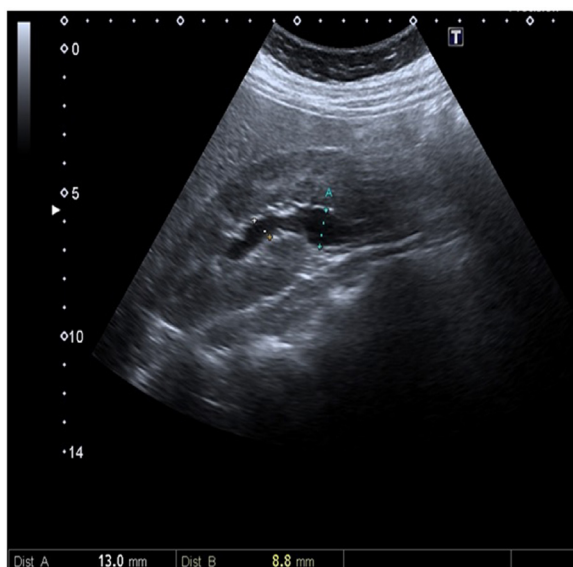
**Figure 1.** Image of the measurement of calyceal system with ultrasound.

Table 4. Correlation between maternal visceral adipose tissue thickness and subcutaneous adipose tissue thickness

The maternal visceral adipose tissue thickness	The maternal subcutaneous adipose tissue thickness	
	r	P-value
	.993	.001

$p < 0.05$ was considered as statistically significant. Pearson correlation analysis was used.

known. Therefore, we aimed to establish one of the etiologic factors for maternal pelvicalyceal dilatation. The most frequently used explanatory mechanisms are the pressure of the growing uterus and the relaxing effect of progesterone. It has been observed that in cases in which the uterus grows more, such as polyhydramnios and multiple pregnancies, hydronephrosis can occur more frequently⁽¹⁰⁾. In 2004, Çoban et al. evaluated the relationship between estimated fetal weight, birth weight, and maternal hydronephrosis⁽¹³⁾. Similar to our study, they divided patients into 3 groups according to the maximal calyceal dilatation as defined by Zwergel et al.⁽¹¹⁾. Eighty-eight pregnant women with symptomatic hydronephrosis were included in their study and the estimated fetal weight at the time of the diagnosis and maximal calyceal dilatation were found to be related to pelvicalyceal dilatation grade. Similar to our study, patients with polyhydramnios, oligohydramnios, and multiple pregnancies were excluded from their study because these conditions can change the degree of calyceal dilatation. However, in Çoban's study, maternal BMI, VAT, and SAT thicknesses, which can affect maternal calyceal dilatation, were not taken into account⁽¹³⁾.

Hydronephrosis usually occurs in the second half of the pregnancy and mostly regresses a few weeks after delivery^(7,9). In a study performed in 2014, it was found that symptomatic hydronephrosis was diagnosed on average in the 26th week of pregnancy⁽¹³⁾. Therefore, we evaluated maternal calyceal system dilatation in the third trimester of our pregnancies. Four weeks after birth, follow-up renal ultrasound was performed on the available patients and we found that the maternal calyceal dilatation had regressed.

In pregnancy, percutaneous interventions in nephrolithiasis, except for hydronephrosis, should not be preferred as a first-line treatment, especially in the first half of pregnancy⁽¹⁴⁾. However, nephrolithiasis can be treated using ultrasonography-guided, percutaneous minimally invasive procedures after the second trimester. Symptomatic hydronephrosis in pregnancy can be treated conservatively, especially mild hydronephrosis^(7,12,15,16). A double-pigtail stent insertion can be performed if the patient's condition is refractory to conservative management and severe hydronephrosis. The first choice should be conservative management due to surgery-related discomfort and the risk of complications^(12,17). We also treat our patients with symptomatic hydronephrosis conservatively.

In a recently published study, it was reported that there was no association between the grade of maternal hydronephrosis and the duration of pregnancy and perinatal mortality⁽¹³⁾. Similar to this study, we had only one patient who delivered before the 37th week and no perinatal complications occurred in any patients.

Ultrasound is a non-invasive, reliable, reproducible

and valid method for the assessment of VAT and SAT thicknesses⁽¹⁸⁾. Ultrasound is also more feasible in evaluating VAT and SAT thicknesses than computed tomography or magnetic resonance imaging, because it is a non-ionizing low-cost imaging method that is widely accessible, especially for pregnant women⁽¹⁹⁾. We used ultrasound to evaluate SAT and VAT thicknesses.

In our study, a correlation was found between maternal BMI, SAT thickness, VAT thickness, and maternal pelvicalyceal dilatation. We think that the main protective factor against the mechanical pressure of the uterus on the kidneys can be related to maternal visceral adipose tissue. SAT and VAT measurements are correlated and it is clear that SAT measurements with ultrasound are easier to perform than VAT measurements and do not require as much experience as VAT measurements. Also, SAT measurements can be easily evaluated by obstetricians during obstetric ultrasonography for pelvicalyceal dilatation estimation. Furthermore, the SAT was found to be a predictor factor in maternal hydronephrosis occurrence. With measuring SAT besides obstetric ultrasound helps clinicians to estimate maternal pelvicalyceal status. BMI of the patients which can be calculated without special device requirements such as ultrasound was also helpful in maternal hydronephrosis occurrence. Our results are important in the selection of suitable patients to be referred to radiologists for renal ultrasonography.

The main limitation of our study is that the patient numbers of the groups are not homogeneous. Secondly, we did not separate the patients according to their BMI. However, to the best of our knowledge, our study is the first in which a relationship between BMI, and VAT and SAT thicknesses, and maternal pelvicalyceal dilatation development has been shown. Asymptomatic hydronephrosis is a very frequent condition in pregnancy; however, it can rarely proceed to acute renal failure.

CONCLUSIONS

With this study, it has been shown that BMI, and SAT and VAT thicknesses can be associated with maternal pelvicalyceal system dilatation, which is frequently seen among the physiologic changes of pregnancy. We think that increasing maternal adipose tissue may have a protective effect against the mechanical pressure of the growing uterus on the ureters. In clinical practice, it should be kept in mind that the pelvicalyceal system dilatation can be seen more frequently in slim pregnant women with unexplainable pelvic disorders.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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