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Original Research

The Effect of Full and Empty Bladders on Uterine Artery Doppler Parameters in the First Trimester

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Abstract

Background: The presence of increased resistance in uterine artery Doppler measurements is associated with preeclampsia and other adverse pregnancy outcomes. Therefore, this study aimed to evaluate whether a full or empty bladder affects uterine artery Doppler results. **Methods**: This study included 213 women with singleton pregnancies between 11–13 weeks. The first measurement for bilateral uterine artery Doppler parameters was performed while the patients experienced a full bladder, while the second measurement was conducted immediately following urination. **Results**: Uterine artery notching presented statistically significant results when the bladder was evaluated as full and empty. While the mean values calculated for the left uterine artery pulsatility index were 1.82 $\pm$ 0.04 before micturition, this value was calculated as 1.74 $\pm$ 0.04 after micturition ($p = 0.011$). The mean value for the right uterine artery while the mean value was 1.85 $\pm$ 0.042 before micturition, it was calculated as 1.81 $\pm$ 0.041 after micturition ($p < 0.001$). Uterine artery resistance indices were also statistically different before and after micturition. The mean values calculated for the left uterine artery resistance index were 0.77 $\pm$ 0.008 before micturition and 0.74 $\pm$ 0.007 after micturition ($p = 0.003$). For the right uterine artery, it was calculated as 0.76 $\pm$ 0.008 before micturition and 0.75 $\pm$ 0.01 after micturition ($p = 0.047$). **Conclusions**: Although there are minimal studies on this subject in the literature are limited, physiological principles and the results of the present study show that emptying the bladder before arterial Doppler evaluation of spaces such as the abdominal compartment, will provide more accurate results.

Keywords: Doppler; pregnancy; ultrasonography; urinary bladder; uterine artery

1. Introduction

Doppler ultrasonographic evaluation of the uterine arteries during the first trimester is a frequently used method for the prediction of uteroplacental pathologies such as preeclampsia and fetal growth restriction [1–3]. The presence of increased resistance in uterine artery Doppler measurements is associated with preeclampsia and other adverse pregnancy outcomes [4–6]. This evaluation method, which is considered to provide very valuable information about the uteroplacental unit, is performed with a standardized technique, it is very easy to apply, and little attention is paid as to whether the pregnant patient's bladder is full or empty [7]. However, theoretically, bladder distension could potentially increase uterine artery resistance indices by stretching the vessels. When the limited number of studies on this subject in the literature were evaluated, it appeared that a full bladder increased uterine artery resistance [8]. We aimed to present the results of our study in which we evaluated the effect of bladder distension on uterine artery flow parameters.

2. Methods

The necessary permissions for the realization of this study were obtained from the Canakkale Onsekiz Mart University Clinical Research Ethics Committee (18920478-050.01.04-E.2000149840; 23.09.2020). The study consisted of pregnant patients who applied to the tertiary healthcare unit of Canakkale Onsekiz Mart University Hospital, Gynecology, and Obstetrics Clinics between January 2022 and June 2022. Informed consent was obtained from all participants before the study and the principles of the Declaration of Helsinki were applied. The inclusion criteria were being between 17–43 years of age, being between 11 w+2 d and 13 w+6 d gestational week, and having a singleton pregnancy. The study was conducted with 213 patients who met the inclusion criteria. Gestational age was calculated from the last menstrual period and was confirmed by a fetal crown-rump length measurement. Ultrasonographic evaluation was performed by 2 specialist physicians using high-resolution probes Voluson® S6 (© 2016 General Electric Company. Connecticut, ABD). All participants filled out a form containing demographic characteristics such as their last menstrual period, gravity, parity,

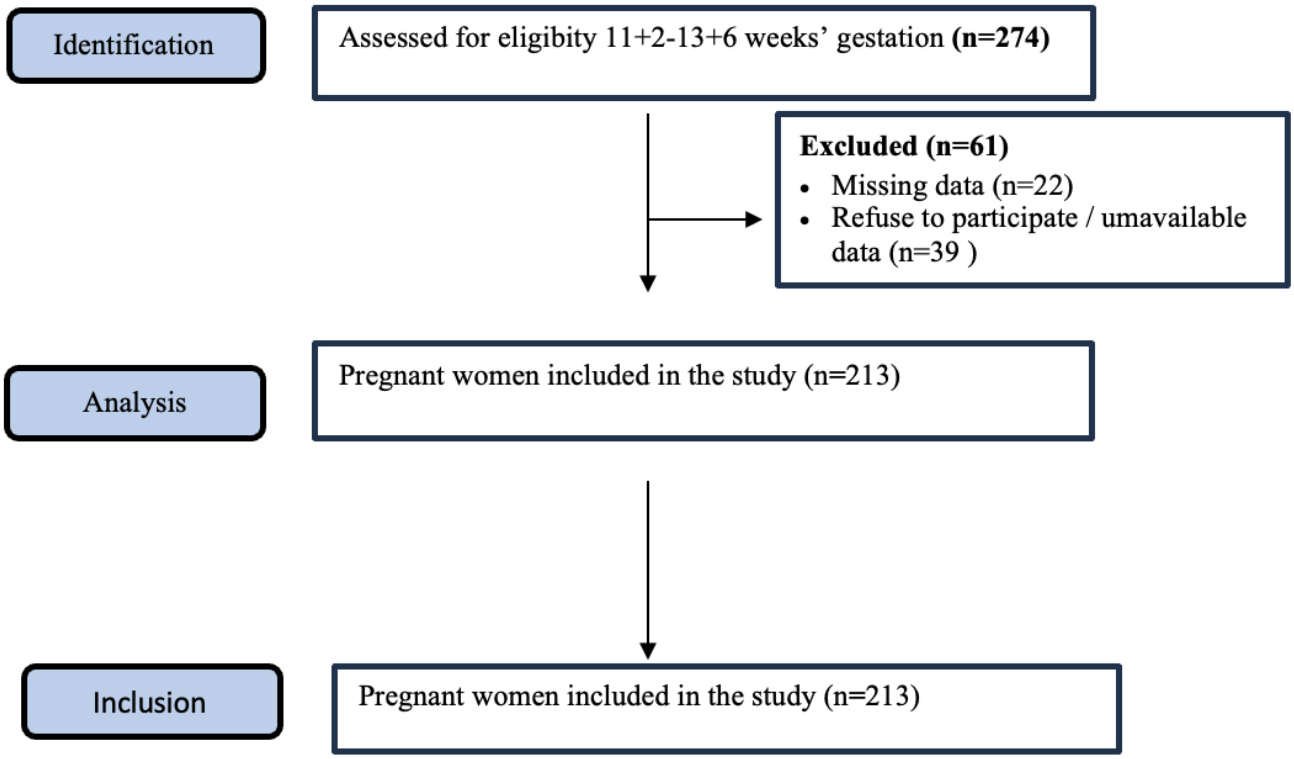

Fig. 1. Flow diagram of patient recruitment.

number of abortions, age, height, and weight. The formula of dividing the body weight in kilograms by the square of the height in meters was used to calculate the Body Mass Index. Those with hypertension, diabetes, vasculopathy, multiple pregnancies, smoking or current use of anticoagulant drugs were not included in the study. The first measurement for bilateral uterine artery Doppler parameters was performed while the patients were experiencing a full bladder, and the second measurements were made just after the patients urinated (empty bladder). To do this, all participants were asked before and after the test whether they felt the urgency to urinate (Fig. 1).

2.1 Doppler Ultrasonographic Evaluation of Uterine Arteries

The uterine arteries were visualized by obtaining an image of the cervical canal and slowly shifting the ultrasonography probe to the right and left sides. During the arterial pulsed Doppler sonography, the insonation angle was set to be less than 30° and the sample spacing was set to 2 mm. In this way, at least 3 wavelengths were recorded. Bladder volume was calculated by measuring 3 orthogonal bladder diameters and applying the volume formula of an ellipsoid shape (rostrocaudal diameter × transverse diameter × anteroposterior diameter × 0.523).

2.2 Statistical Analysis

All data were recorded on the SPSS 25.0 (SPSS Inc., Chicago, IL, USA). The suitability of the parameters to the normal distribution was evaluated with the Kolmogorov-Smirnov Test. Since our parameters were in accordance with the normal distribution, the paried sample *t*-test was used and the Chi-Square Test was used for categorical variables. continuous and categorical variables were compared in terms of Mean ± SD/n, Min-Max. Results with a *p*-value of <0.05 were considered statistically significant.

3. Result

The study, planned with 274 patients, was completed with 213 patients, 61 patients were excluded from the study because of missing data (n = 22) and refusing to participate/unavailable data (n = 39) (Fig. 1). The quality of the images was considered satisfactory, and no case was excluded from the analysis. Therefore, all 213 cases were evaluated. The mean age of the women included in the study was 28.10 ± 5.54 years. The average of the Body Mass Indexes calculated by the standardized method was 25.96 ± 5.42 kg/m^2. It was the first pregnancy of 38% (n = 81) of the cases and 62% (n = 132) of them had more than 1 pregnancy. Again, 46.9% (n = 100) of the cases were primigravid, 38.50% (n = 82) had 1 delivery, and 14.60% (n = 31) had more than 1 delivery. Other characteristics of the cases forming the study sample are presented in (Table 1).

Uterine artery notching revealed statistically significant results when the bladder was evaluated as full and empty. While notching was observed in the left uterine artery in 94 cases before micturition, notching continued in only 39 of these cases after micturition. The *p*-value was

Table 1. Demographic characteristics of the population are presented.

	Mean ± SD	Minimum	Maximum	Median
Age (year)	28.1 ± 5.54	17.00	43.00	28.00
BMI (kg/m^2)	25.96 ± 5.42	15.40	51.60	24.90
CRL (mm)	60.10 ± 9.28	45.90	84.00	59.00
NT (mm)	1.34 ± 0.25	0.80	2.20	1.32
Bladder volume (before micturition) (mL)	261.34 ± 18.44	221.00	298.00	262.00
Bladder volume (after micturition)	12.03 ± 8.17	1.00	38.00	10.00

BMI, Body mass index; CRL, Crown-rump lenght; NT, Nuchal translucency; SD, standard deviation; kg/m^2, kilogram/square meter; mm, millimeter; mL, milliliter. Normality of the data was evaluated with skewness and kurtosis.

Table 2. Comparative data on notching of uterine arteries before and after micturition.

	After micturition yes (n)	After micturition no (n)	Total (n)	p value
Left UtA before micturition yes	39	55	94	<0.001
Left UtA before micturition no	17	102	119	
Right UtA before micturition yes	33	49	82	<0.001
Right UtA before micturition no	21	110	131	

UtA, uterine artery; n, sample size. Significant difference at $p < 0.05$ by statistical value χ^2 test.

Table 3. Comparative data on resistance indices and pulsatility indices of uterine arteries before and after micturition.

	Before micturition	After micturition	t test	n	p value
	Mean ± SD	Mean ± SD			
Left UtA-PI	1.82 ± 0.04	1.74 ± 0.04	2.052	213	0.011
Right UtA-PI	1.85 ± 0.042	1.81 ± 0.041	0.908	213	<0.001
Left UtA_RI	0.77 ± 0.008	0.74 ± 0.007	2.598	213	0.003
Right UtA_RI	0.76 ± 0.008	0.75 ± 0.01	0.581	213	0.047

UtA, uterine artery; PI, Pulsatility index; RI, Resistance index; SD, standard deviation; n, sample size. Normality of the data was evaluated with skewness and kurtosis values and significant difference at $p < 0.05$ by t-test.

calculated as <0.001 and showed a statistically significant decrease after micturition. The situation was similar in the right uterine artery (p-value was calculated as <0.001) and showed a statistically significant decrease after micturition. The number was 82 before micturition and 33 after micturition. Right uterine artery notching value was examined before and after micturition, and it was found that the notching value decreased at a statistically significant level ($p < 0.001$) (Table 2).

While the mean values calculated for the left uterine artery pulsatility index were 1.82 ± 0.04 before micturition, it was calculated as 1.74 ± 0.04 after micturition ($p = 0.011$). For the right uterine artery while the mean value was 1.85 ± 0.042 before micturition, it was calculated as 1.81 ± 0.041 after micturition ($p < 0.001$). Uterine artery resistance indices were also statistically different before and after micturition. The mean values calculated for the left uterine artery resistance index were 0.77 ± 0.008 before micturition and 0.74 ± 0.007 after micturition ($p = 0.003$). For the right uterine artery, it was calculated as 0.76 ± 0.008 before micturition and 0.75 ± 0.01 after micturition ($p = 0.047$). Detailed data on the results are presented in Table 3.

4. Discussion

Uterine artery Doppler flow parameters can be affected by hormonal changes in the menstrual cycle, blood pressure, maternal heart rate, and various drugs. It is an important factor in determining the flow of uteroplacental vessels during pregnancy. In our study, apart from the known factors, it was investigated whether bladder fullness or emptying was also an important factor. The right and left uterine artery notching values were examined before and after micturition, and it was found that the notching value decreased at a statistically significant level. The pulsatility indices of uterine arteries before and after voiding were examined. It was observed that the change in the left and right uterine artery pulsatility index was statistically significantly lower. Our results showed that the state of the bladder affects Uterine Artery Resistance and Pulsatility Index. Doppler Pulsatility Index (PI) and Resistive Index (RI) are frequently used to predict preeclampsia [9,10]. In their study conducted with 51 pregnant patients, Özel and Şen [11] reported that whether the bladder is full or empty does not affect the Uterine Artery Pulsatility Index and Uterine Artery Notching. The mean age of the population stud-

ied was 30.3 $\pm$ 5.6 years, and the Body Mass Index was 23.9 $\pm$ 4.2 kg/m^2 [11]. The results of this study are important in terms of having similar characteristics to the population we evaluated. However, the results obtained in the present study were different from the results of Özel and Şen [11]. In our study, it was found that the state of the bladder affected the pulsatility and resistance indices, including uterine artery notching. In their study on 45 pregnant women, Seravalli *et al*. [8] found similar findings as compared with the results of Özel and Şen [11]. Battaglia *et al*. [12], in their study conducted with 39 non-pregnant women, found significantly higher Doppler indices measured when the bladder was full. They explained this result by the fact that the reactions related to increased sympathetic innervation during bladder filling also affected the vasoconstrictive sympathetic nerves in the periarterial region of the uterine arteries. The results of Battaglia *et al*. [12] were in line with our results, although their study was not conducted with pregnant patients. Reported that first-trimester uterine artery Doppler Flow Evaluation predicted preeclampsia and small for gestational age that might develop in the following weeks of pregnancy. The important feature of this study was that all of the pregnant patients included in the study stated that their bladder was empty [13]. We think that it would be correct to explain the results obtained from our study with the increase in abdominal compartment pressure. The pressure exerted on arteries and veins by the uterus, which enlarges and expands in volume and weight during pregnancy, is obvious, especially in the supine position. In addition, a full bladder occupies a certain volume in the abdomen and an increased bladder volume applies pressure to the uterus. Therefore, we suggest that emptying the bladder before the evaluation of the uterine arteries with Doppler may affect the Uterine Artery Flow to a certain extent.

The main limitation of the present study was that since our hospital is a tertiary advanced healthcare center, the patients who apply generally have additional diseases. These patients were excluded. Another limitation was that the ultrasound measurements were made before and after micturition, which was very time-consuming for each patient. This obstacle was overcome by planning to measure only 4 patients per day.

5. Conclusion

Although there are not enough studies on this subject in the literature, physiological principles and our study show that emptying the bladder before arterial Doppler evaluations of spaces such as the abdominal compartment may give more accurate results.

Availability of Data and Materials

The data that support the findings of this manuscript can be provided on request from the first author.

Author Contributions

MND: study selection, data extraction, risk of bias assessment and manuscript revision, statistical analysis; SSD: manuscript drafting and revision, study selection, data extraction, risk of bias assessment, manuscript drafting and revision; LSD: conceptualization, supervision and manuscript revision statistical analysis, manuscript drafting and revision; IEP: original draft, conceptualization, data extraction, risk of bias assessment and manuscript revision; SKI: data extraction, statistical analysis, manuscript drafting and revision; BD: study selection, data extraction, risk of bias assessment, statistical analysis, manuscript drafting, and revision. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The necessary permissions for the realization of this study were obtained from the Canakkale Onsekiz Mart University Clinical Research Ethics Committee with the approval numbered: 18920478-050.01.04-E.2000149840, date: 23.09.2020. Informed consent was obtained from all participants before the study and the principles of the Declaration of Helsinki were applied.

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Conflict of Interest

The authors declare no conflict of interest.

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