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Comparison of Ultrasonographic Transabdominal and Transvaginal Measurements in Second Trimester Cervical Length Screening: Reliability of Transabdominal Measurement: A Prospective Study

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ABSTRACT Objective: To investigate the reliability of transabdominal ultrasonography (TAUS), which can be used as an alternative to transvaginal ultrasonography (TVUS), which is a gold standard method in cervical length measurement. The study also aimed to determine the cut-off values for TAUS that can predict the short cervix detected in TVUS. **Material and Methods:** The prospective study included 204 pregnant women. The cervical lengths (CL) of the patients were measured using TAUS and TVUS. The sensitivity, specificity, positive predictive value, and negative predictive values of the measurement methods were calculated. The TVUS CL threshold value used to define the short cervix was determined as <25 mm. **Results:** TAUS bladder-full CL measurements were statistically and significantly higher than bladder-empty TAUS measurements. A positive correlation was detected between the TVUS and TAUS CL measurements. The sensitivity of the TAUS bladder-full method was found to be 25% in detecting the short cervix with a specificity of 99.5%. The sensitivity of the TAUS bladder-empty method was found to be 50% with a specificity of 99.5%. The cut-off values for TVUS short cervix prediction were found to be 28 mm for TAUS bladder empty and 32 mm for TAUS bladder full. **Conclusion:** We recommend that TAUS be performed first in low-risk patients regarding preterm birth. When the CL is measured as 32 mm with a full bladder and 28 mm with an empty bladder in TAUS measurements, we should suspect a short CL and evaluate it with TVUS.

Keywords: Cervical length screening; risk of preterm birth; short cervix; transvaginal ultrasonography; transabdominal ultrasonography

Preterm birth (PTB) is defined as birth before the 37th week of pregnancy and is seen in 5-11% of all pregnancies.[1] The incidence of spontaneous PTB continues to increase even in low-risk women.[2] PTB is a leading cause of neonatal morbidity and mortality that cannot be associated with congenital anomalies or aneuploidy. The risk of mortality in the 1st year of life of a baby born prematurely is 40-fold higher than that of a baby born at term.[1] PTB babies who survive experience significant and wide-ranging negative effects throughout their lives.[1]

Most women who give premature birth do not have any known risk factors. The risk factor that has the best correlation with PTB is a previous history of premature birth.[3] Only 10% of women who experience spontaneous PTB have identifiable risk factors based on clinical anamnesis.[4] There is evidence to suggest an association of PTB with a short cervix measured ultrasonographically. A meta-analysis suggested that the rate of PTB can be reduced by treating women with short cervical length (CL) with progesterone.[5] There is great interest in routine ultrasono-

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graphic evaluation of the cervix because there are both a predictive test and a therapeutic intervention.[6]

CL measurement performed using ultrasonography in the second trimester is the typical method of detecting a short cervix in the absence of contractions.[7] Transvaginal ultrasonography (TVUS) has the advantage of directly and clearly imaging the cervix and has become the gold standard in the diagnosis of pregnant women who have a short cervix. However, TVUS is time-consuming and its applicability in screening CL in pregnant women might be limited.[8] In CL evaluation, as an alternative to TVUS, Transabdominal ultrasonography (TAUS) provides an advantage because it is used in routine antenatal examinations. However, the accuracy of the transabdominal (TA) measurement of CL is debated among clinicians. The main concerns include the fact that the CL limit cannot be clearly detected with TAUS and that the bladder filling status of the pregnant woman might confuse the results.[9] CL evaluations performed by using TVUS can be employed for women who have a high risk of preterm birth, such as those with a history of preterm birth, but the application of TVUS is a controversial issue in multigravida or primigravida women who have a history of full-term pregnancy.[10]

The purpose of the present study was to determine the reliability of TAUS, which is performed with an empty or full bladder, which can be an alternative to TVUS, which is the gold standard method in CL measurement to predict PTB in the low-risk obstetric population. The study also aimed to find cut-off values for TAUS that can predict short cervix (<25 mm) detected in TVUS.

MATERIAL AND METHODS

A total of 204 pregnant women who were between 18-24 weeks of gestation who applied to the Dicle University Faculty of Medicine Gynecology and Obstetrics Clinic between June-December 2022 for 2nd-trimester routine ultrasonography screening were included in this prospective study. The approval was received for the study from the Ethics Committee of Dicle University Faculty of Medicine with the number 75 on February 06, 2020. Written informed consent was obtained from each patient before inclusion in the study. The protocol was conducted in line with the Declaration of Helsinki Principles.

The patients who had low risks for PTB were included in this study. Those who had a singleton pregnancy, who had not undergone cerclage in their current pregnancy, and who had no history of PTB were included in the study. Patients who had previously undergone cervical surgery (loop electrosurgical excision procedure or conization), patients with membrane rupture in their current pregnancy, patients with uterine anomalies, patients with premature labor such as vaginal bleeding or uterine contraction, fetal anomalies, and intrauterine mortality were not included in the study.

Cervical lengths were measured in all patients included in our study in mm with TAUS when their bladder was full and after voiding and with TVUS after voiding. The pregnancy weeks, demographic characteristics, and CL of the patients were recorded. Ultrasonography measurements were made by 2 research assistants and a faculty member trained in our clinic. After the ultrasonographic fetal anatomical evaluations of the patients, TA bladder-full and post-voiding measurements were made while the patient was in the supine position. Right after post-voiding TA, the patient was prepared in the elevated lithotomy position, and transvaginal (TV) CL measurement was made by placing the calipers on the internal and external os to include only the closed length where the endocervical canal walls contacted or were limited by the endocervical mucosa. The TV method was used as the reference measurement for the CL. The bladder depth of the patients considered to have a full TA bladder was taken as >30 mm. The TVUS CL threshold value used to define the short cervix was determined as <25 mm. The device used was a Samsung Hera W9 that had a convex probe 2-9 Mhz (CA2-9A), 3d convex probe 1-8 Mhz (CV1-8A), and a TV probe 2-11 Mhz (EA2- 11AV) multifrequency transducers (Samsung Medison Healthcare, Seoul, Korea).

The suitability of the numerical variables for normal distribution was tested with the Shapiro-Wilk test. The Wilcoxon Rank test was used to compare 2 dependent measurements that were not normally distributed. The relationships between the numerical variables were tested with the Spearman rank correla-

tion coefficient. Receiver operating characteristic curve analysis was used to determine the cut-off points of the variables. The compatibility of the methods was evaluated with the Bland-Altman Plot. The sensitivity, specificity, positive predictive value, and negative predictive value (NPV) were calculated for the method comparisons. The analyses were conducted with the SPSS 22.0 Windows (IBM Corp., Armonk, NY, USA) version package program and MedCalc 20.115 (MedCalc Software Ltd, Ostend, Belgium) program and $p<0.05$ was considered significant.

RESULTS

The mean age of the patients who were included in the study was 28.87±5.63 years, the mean gestational age was 20.71±2.22 weeks, the mean TAUS CL with a full bladder was 37.76±6.78 mm, the mean TAUS CL with an empty bladder was 37.32±6.73 mm, and the mean TVUS CL with an empty bladder was 38.46±6.79 mm (Table 1, Table 2).

When TAUS and TVUS CL measurements were compared, TVUS CL was found to be significantly higher than TAUS bladder full and empty bladder lengths ($p=0.001$). When the CL measured during TAUS with a full and empty bladder were compared, the TAUS bladder-full CL measurements were found to be statistically significantly higher ($p<0.05$) (Table 3). It was also found that 26.5% (54) of the patients who were included in the study were primigravida and 73.5% (150) were multigravida.

When the correlation between 2 different methods in the CL measurements was evaluated, a strong and positive correlation was detected between the TVUS CL measurements and the TAUS bladder empty measurements ($r=0.779$, $p=0.001$). A strong and positive correlation was detected between TVUS CL measurements and TAUS bladder full measurements ($r=0.829$, $p=0.001$) (Table 4). When the correlation between a gestational week and TVUS, TAUS bladder full, and TAUS bladder empty measurements was evaluated, no relationships were detected between the gestational week and different methods of CL measurements ($p>0.05$).

It was found that the sensitivity of the TAUS bladder-full method in detecting patients with a short

TABLE 1: Evaluation of the demographic data

	X̄±SD n=204
Age (years)	28.87±5.63
Gravida	3.22±2.1
Parity	1.56±1.53
Abortion	0.63±1.16
Alive	1.47±1.5
Pregnancy week	20.71±2.22
TAUS bladder full mm	37.76±6.78
TAUS bladder empty mm	37.32±6.73
TVUS mm	38.46±6.79

SD: Standard deviation; TAUS: Transabdominal ultrasonography; TVUS: Transvaginal ultrasonography

TABLE 2: Percentile values of the CL measurements

	TAUS bladder full mm	TAUS bladder empty mm	TVUS mm
Percentile 05	29.00	29.00	30.00
Percentile 25	34.00	34.50	36.00
Median	37.00	37.00	38.00
Percentile 75	40.00	39.50	41.00
Percentile 95	52.00	52.00	52.00

TAUS: Transabdominal ultrasonography; TVUS: Transvaginal ultrasonography

TABLE 3: Comparison of the CL measurements

	X̄±SD	Average difference	
TAUS bladder full mm	37.76±6.78	-0.69±3.54	0.001*
TVUS mm	38.46±6.79		
TAUS bladder empty mm	37.32±6.73	-0.44±2.58	0.001*
TVUS mm	38.46±6.79		
TAUS bladder full mm	37.76±6.78	0.44±2.58	0.019*
TAUS bladder empty mm	37.32±6.73		

*Significant at $p<0.05$, The Wilcoxon test. SD: Standard deviation; TAUS: Transabdominal ultrasonography; TVUS: Transvaginal ultrasonography

TABLE 4: Transabdominal and transvaginal correlation of the CL measurements

		TVUS mm
TAUS bladder full mm	r value	0.829**
	p value	0.001
	n	204
TAUS bladder empty mm	r value	0.779**
	p value	0.001
	n	204

**Significant at $p<0.05$ level; r: The Spearman rank correlation coefficient. TVUS: Transvaginal ultrasonography; TAUS: Transabdominal ultrasonography

cervix (<25 mm) by TVUS was 25% with a specificity of 99.5%, a positive predictive value (PPV) of 50%, and a NPV of 98.5%. In detecting patients with a short cervix (<25 mm) by TVUS, the sensitivity of the TAUS bladder empty method was 50% with a specificity of 99.5%, a PPV of 66.6%, and a NPV of 99% (Table 5).

TABLE 5: The sensitivity, specificity, Negative Predictive Value, PPV values of TAUS cervical lengths in detecting cervical lengths below 25 mm with TVUS

TAUS bladder full		
Sensitivity (95% CI)	25.00%	0.63% to 80.59%
Specificity (95% CI)	99.50%	97.25% to 99.99%
PPV (95% CI)	50.00%	6.98% to 93.02%
NPV (95% CI)	98.51%	97.41% to 99.15%
TAUS bladder empty		
Sensitivity (95% CI)	50.00%	6.76% to 93.24%
Specificity (95% CI)	99.50%	97.25% to 99.99%
PPV (95% CI)	66.67%	18.34% to 94.69%
NPV (95% CI)	99.00%	97.39% to 99.62%

TAUS: Transabdominal ultrasonography; CI: Confidence interval; NPV: Negative predictive value; PPV: Positive predictive value

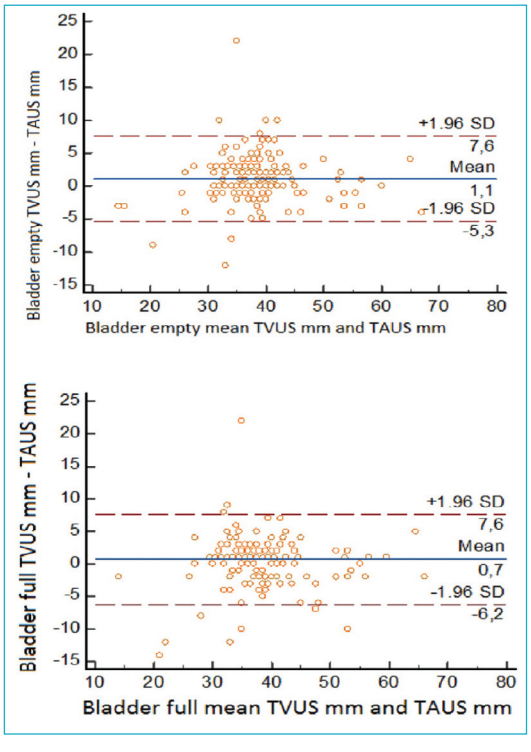

FIGURE 1: Distributions of CL measurements, Bland Altman chart
TVUS: Transvaginal ultrasonography; TAUS: Transabdominal ultrasonography; SD: Standard deviation

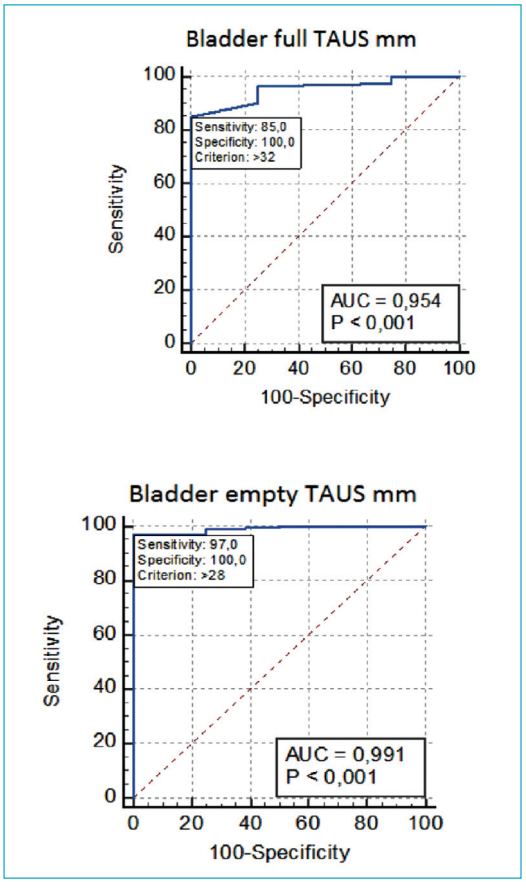

FIGURE 2: Cut-off transvaginal CL=25 mm, receiver operating characteristic curve analysis
TAUS: Transabdominal ultrasonography; AUC: Area under the curve

When TVUS and TAUS CL that were measured with the Bland Altman Chart were evaluated, it was found that the difference between both TAUS bladder empty and TAUS bladder full and TVUS CL measurements was statistically significant; in other words, there was a difference between the methods. TVUS appeared to be significantly reliable compared to the CL that were measured with TAUS when the bladder was empty and with TAUS when the bladder was full ($p<0.05$) (Figure 1).

It was also found that the TAUS bladder empty CL value of 28 mm could predict a short cervix of 25 mm with TVUS with 97% sensitivity and 100% specificity. The TAUS bladder-full CL value of 32 mm could predict a short cervix of 25 mm with TVUS with 85% sensitivity and 100% specificity ($p<0.001$) (Figure 2).

DISCUSSION

Cervical screening is important because an asymptomatic short cervix is a strong indicator of PTB and can be treated to reduce preterm birth. Obstetricians and gynecologists need a reliable, effective, and optimal method of cervical screening to detect pregnant women at risk of PTB. There is no consensus on the best approach to cervical screening, specifically whether all women should receive TV screening or whether it must be restricted to those who have a short cervix at the initial TA evaluation. Our purpose was to compare the values found by performing CL measurements with TAUS, bladder full, empty, and TVUS on each patient included in the study, and to determine the reliability of TAUS, which would be more comfortable for the patients, and the cut-off values that can be used to predict a short cervix. As a result of the present study, it was found that TVUS is more reliable and when the TA measurements were evaluated, the sensitivity and PPV of TAUS values measured when the bladder was empty were more reliable in detecting short cervix. We concluded that when the CL is measured 32 mm with a full bladder and 28 mm with an empty bladder in TAUS measurements, we should suspect a short CL and evaluate it with TVUS.

In the study that was conducted by Peng et al. in a low-risk population for PTB, TA and TV CL measurements were performed on 174 2nd-trimester pregnant women after voiding and it was found that the average TA CL was shorter than 1.6 mm TV measurements. The 5th percentile values for TV and TA measurements were reported to be 29.1-29 mm, respectively, and the TA cut-off value to detect a short cervix was reported to be 29 mm.[8] In their study, O'Hara et al. measured CL with the TA and TV method when the bladder was full and empty and reported that bladder-full TA values were on average 14 mm higher than TV values, and there was a 0.06 mm difference between empty bladder TA and TV measurements. It was found that the empty bladder TA measurement value to detect a short cervix on TV was 30 mm. It was reported that bladder empty TA and TV measurements correlated better.[11] Marren et al. examined the bladder-full TA, bladder-empty TA, and TV and CL values of 198 pregnant women. They concluded that bladder-full TA over-measured the value (mean 6.1 mm) and that all women should be advised to have their CL measured on TV as a screening test for PTB.[4] In another study that included 771 patients, CL measurement could not be performed with TA in 19.3% of the patients and it was reported that there were no differences between the averages of TA and TV CL measurements. TA measurements showed that a short cervix was correlated with TV and it was stated that TV was not necessary in those whose CL was found to be sufficient with TA. However, TV was recommended in cases that could not be measured using TA or were found to be short.[12] When the values in our study were interpreted by considering the data of other studies in the literature, the average of CL measurements during both TAUS bladder-full and bladder-empty cases was measured to be shorter than TVUS measurements (-0.69, -0.44, respectively). TAUS measurements that were made when the bladder was full were found to be higher than TAUS measurements made when the bladder was empty and statistically significant differences were detected between the values. When the correlation between the TA and TV methods was evaluated, a positive correlation was detected between these methods. When the distributions of CL values were examined according to the methods in our study, it was found that TVUS was more reliable than TA bladder full and empty measurements. To detect a short cervix, the cut-off value was 32 mm for the TAUS bladder full measurement and 28 mm for the TAUS bladder empty measurement. In line with these data, we need to know that the values obtained in TAUS measure the CL less than TVUS, regardless of bladder fullness. We believe that the measurements must be confirmed with TVUS in patients whose CL measurements are found to be below the cut-off values determined in our study.

In their study, Nambiar et al. reported that TA CL measurement performed when the bladder was half full detected a short cervix with 100% sensitivity and 92.4% specificity when it was 29 mm.[13] Westerway et al. performed CL measurements on pregnant women with their TA bladder full and their TV bladder empty. The sensitivity of TA, which can detect a

short cervix, was reported to be 10% and the specificity was stated as 94%. In addition, the cut-off value to detect a short cervix was stated as 32 mm with 77% sensitivity and 58% specificity.[14] In our study, when the sensitivity, specificity, Negative Predictive Value, and PPV of TAUS measurement values when the bladder was full and empty were evaluated for detecting short cervix, the sensitivity of TAUS measurements when the bladder was empty was 50% and PPV was 66.67%, which means that TAUS bladder-empty measurements were higher than TAUS bladder full measurements. Similarly, the cut-off value to predict a short cervix was determined to be 28 mm for TAUS bladder empty CL with 97% sensitivity and 100% specificity. Because of these data, it is possible to argue that among the CL measurement methods, TAUS bladder empty measurements are more sensitive than TA values with a full bladder. We may recommend that TAUS be performed first in populations with low risk of PTB when the bladder is empty to measure CL before TVUS in routine ultrasonography evaluation.

TVUS is considered the gold standard for CL assessment to predict PTB as it is highly reproducible and is not affected by maternal obesity, cervical position, and shadowing of the fetal parts.[15,16] However, universal TVUS is time-consuming and more expensive, and some women may refuse to have TV performed during their examinations because of embarrassment and discomfort.[17,18] TAUS is more convenient for patients and clinicians and can be easily performed during routine obstetric examinations. According to many previous studies, TAUS CL measurements have many limitations, especially in terms of visualization and accuracy. The internal cervical os may not be visible in those who have previous surgery scars and in obese women. The cervix may be covered by the mother's pubic bone or a part of the fetus in TAUS.[12] Considering the advantages and disadvantages of TAUS and TVUS, in light of the correlations in our study, we found that both methods had a positive correlation with each other.

The limitation of the present study was that TAUS and TVUS CL values were determined according to normal CL because our study was conducted with pregnant women who were at low risk of preterm birth. Another limitation of the study was that the body mass index of the patients were not recorded and the CL measurements were performed by 2 research assistants. The advantages of the study were that it was conducted in a tertiary hospital, in a single healthcare center, and was prospective.

CONCLUSION

It was determined in this study that TVUS is more reliable. When TA measurements were evaluated according to bladder fullness, it was found that the sensitivity and PPV of TAUS measured when the bladder was empty were higher in detecting short cervix. When TAUS was first performed on the patients and the bladder was measured as 32 mm when full and 28 mm when empty, it was concluded that we should suspect short CL and evaluate it with TVUS.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

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