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Investigation of transvaginal and transabdominal ultrasound and bladder fullness in the evaluation of cervical length in low-risk pregnant women

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Abstract

Objective: Cervical length is an important ultrasonographic marker used to predict cervical insufficiency and preterm labor. Our aim in this study was to compare TA and TV cervical lengths in three trimesters and to investigate the effect of bladder fullness on TA measurements.

Methods: This study was planned as a prospective cross-sectional study and low-risk pregnant women between 11–37 weeks who presented to the hospital were included in the study. The patients were divided into three groups according to their trimesters, and the cervical lengths of the patients were assessed first with TA and then TV ultrasound with a full bladder and then an empty bladder.

Results: The mean cervical length was 45.6±7.0 cm in first-trimester patients, 42.8±7.0 cm in second-trimester patients, and 41.0±8.5 cm in third-trimester patients. Although TV cervical length was longer in all three trimesters, no statistically significant difference was found between TV and TA ultrasound with a full bladder ($p>0.05$). When TA ultrasound with empty bladder and TV ultrasound were compared, the TV measurements were found to be statistically significantly longer in each trimester ($p<0.05$). It was shown that parity number, fetal presentation, and obesity did not affect TV or TA assessment with a full bladder ($p>0.05$).

Conclusion: TV and TA assessment with a full bladder were found similar in all three trimesters. TA ultrasound with a full bladder can be safely used for cervical length measurement in low-risk patients in every trimester.

Keywords: Cervical length, preterm birth, transabdominal, transvaginal, ultrasound.

Özet: Düşük riskli gebelerde servikal uzunluğun değerlendirilmesinde transvajinal ve transabdominal ultrason ve mesane doluluğu incelemesi

Amaç: Servikal uzunluk, servikal yetersizliği ve preterm doğumu öngörmede kullanılan önemli bir ultrasonografi belirtecidir. Bu çalışmadaki amacımız, transabdominal ve transvajinal servikal uzunlukları üç trimesterde karşılaştırmak ve mesane doluluğunun transabdominal ölçümler üzerindeki etkisini araştırmaktı.

Yöntem: Bu çalışma, prospektif kesitsel bir çalışma olarak planlandı ve hastaneye başvuran ve gebeliğin 11–37. haftaları arasında olan düşük riskli gebeler çalışmaya dahil edildi. Hastalar trimesterlerine göre üç gruba ayrıldı ve hastaların servikal uzunlukları, önce dolu ve ardından boş mesaneyle, önce transabdominal, ardından transvajinal ultrason ile değerlendirildi.

Bulgular: Ortalama servikal uzunluk birinci trimesterdeki hastalarda 45.6±7.0 cm, ikinci trimesterdeki hastalarda 42.8±7.0 cm ve üçüncü trimesterdeki hastalarda 41.0±8.5 cm olarak ölçüldü. Transvajinal servikal uzunluk üç trimesterde de en uzun olmasına rağmen, mesane doluyken transvajinal ve transabdominal ultrason arasında istatistiksel olarak anlamlı bir fark bulunmadı ($p>0.05$). Mesane boşken transabdominal ultrason ile transvajinal ultrason karşılaştırıldığında, transvajinal ölçümlerin her trimester istatistiksel olarak anlamlı şekilde daha uzun olduğu bulundu ($p<0.05$). Parite sayısının, fetal prezentasyonun ve obezitenin mesane doluyken transabdominal veya transvajinal değerlendirmeyi etkilemediği bulundu ($p>0.05$).

Sonuç: Mesane doluyken transabdominal ve transvajinal değerlendirme, üç trimesterde de benzer bulunmuştur. Mesane doluyken transabdominal ultrason, düşük riskli hastalarda her trimesterde servikal uzunluğu ölçümü için güvenle kullanılabilir.

Anahtar sözcükler: Servikal uzunluk, preterm doğum, transabdominal, transvajinal, ultrason.

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Introduction

Preterm birth is one of the most common causes of hospitalization during pregnancy. The incidence of preterm labor has increased in recent years due to advanced maternal age, assisted reproductive techniques, and the prevalence of multiple pregnancies.[1] Accurate identification of this situation is important because prematurity is the main cause of perinatal morbidity and mortality.[2] Cervical length is inversely related to the threat of preterm birth; as the cervical length gets shorter, the risk of prematurity increases.[3] Cervical length can be measured using transvaginal (TV), transabdominal (TA) or transperineal ultrasonography. The TA approach stands out because of its ease of implementation and high patient comfort, but TV sonography for cervical length measurement has the advantage of clear visualization of the cervix with a higher-frequency probe than in TA sonography.

Studies are reporting that measurement of cervical length with TV ultrasound is superior to TA ultrasound; however, there is no consensus on the best approach to cervical screening. Moreover there is conflicting data in the literature about universal screening. While some experts support universal screening, others claim that cervical screening can be restricted to women with a short cervix in the first trimester in a TA assessment.[4-7] Considering that the sensitivity of TA assessment of cervical length in the first trimester is reported as 10% in the presence of a short cervix,[8] some patients with a short cervix will be missed in this method. In one study, it was reported that TA ultrasound overestimated 57% of patients with a short cervix (<25 mm).[9] Therefore, the American College of Obstetrics and Gynecology (ACOG) recommends routine cervical length scanning with TV ultrasound at the beginning of the second trimester for pregnant women with a history of preterm birth.[10] Performing cervical length screening for pregnant women without prior preterm birth is controversial, and it is recommended that practitioners who decide to implement universal cervical length screening should follow strict guidelines.[4]

Although cervical length measurement with TV ultrasound seems to be more reliable especially in high-risk patients, TA ultrasound may also be preferred if the patient is sensitive regarding privacy or there is limited time for examination. In the literature, TA and TV methods were usually compared in the same trimester of pregnant women.[1,3,8,11] There are studies stating that bladder fullness is necessary for accurate TA assessment because it makes the endocervical canal more visible.[12] However, there are also studies showing that an overfilled bladder can increase the cervical length by applying pressure on the cervix[13] or that bladder fullness does not affect cervical length measurements.[1,14] In addition, studies investigating the effect of bladder fullness on cervical length are still limited to a single trimester. There are conflicting data in the literature about which method should be preferred to measure cervical length during pregnancy in low-risk patients and whether bladder fullness is required during the TA scans. Our aim in this study was to investigate measurements of cervical length using TA and TV ultrasound and the effect of bladder fullness on TA measurements in all trimesters of pregnancy.

Methods

Study design and patient selection

This prospective cross-sectional study was conducted on low-risk pregnant women who presented to Konya City Hospital between April 2021 and June 2021. Approval for the study was obtained from the local ethics committee (Reg. no: 2021/3212]. All participants were informed about the study and their written informed consent was obtained. The inclusion criteria were as follows: age between 18 and 40 years and single pregnancy between 11 and 37 weeks of gestation. Patients with placenta previa, low-lying placenta, short cervix (<25 mm) cervical cerclage, and inserted pessary, progesterone use, preterm birth history, and preterm birth threat during current pregnancy were excluded from the study. The patients included in the study were divided into three groups as 11–14, 15–28, and 29–37 weeks of gestation. A detailed history was taken from all patients and body mass index (BMI) was calculated. Patients with a BMI of >30 kg/m^2 were considered obese. The gestational age of the fetus was determined according to the last menstrual period or first-trimester ultrasound.

Measurement of cervical length

Cervical length measurements were performed according to the protocol described in previous studies.[15] In all cases, the cervix was assessed first using TA and then TV ultrasound. TA measurements were performed in the supine position twice, once with a full bladder (**Fig. 1a**) and then with an empty bladder (**Fig. 1b**). The TA

assessments of cervical length were performed using a 1–8-MHz linear curved probe, with the image of the entire internal and external os and endocervical canal visible in the midsagittal plane (**Fig. 1a**). Then, in the dorsal lithotomy position with a 3-9–MHz transvaginal probe, when the endocervical canal was fully visible in the sagittal plane, the length of the cervix was measured from the internal os to the external os with minimal pressure on the probe (**Fig. 1c**). In cases where the cervix was obviously curved, a two-line measurement of the endocervical canal was performed. One line between the internal os and the point of major excursion of the endocervical canal, and a second line between this point and the external os was measured, then the two measurements were added together (**Fig. 1d**). Fetal presentation (vertex/ breech) was recorded. All measurements were performed by the same obstetrician (the author) using the same ultrasound device (Mindray DC-70; Mindray Medical International Ltd., Shenzhen, China). The discrepancy between TA and TV measurements was analyzed. In addition, the effect of some maternal and fetal conditions such as parity number, BMI, and fetal presentation on the cervical measurements was compared. Lastly, the effect of bladder fullness on TA measurement in each trimester was investigated.

Statistical analysis

A sample size calculation indicated that a minimum of 35 patients for each trimester would be required to detect a

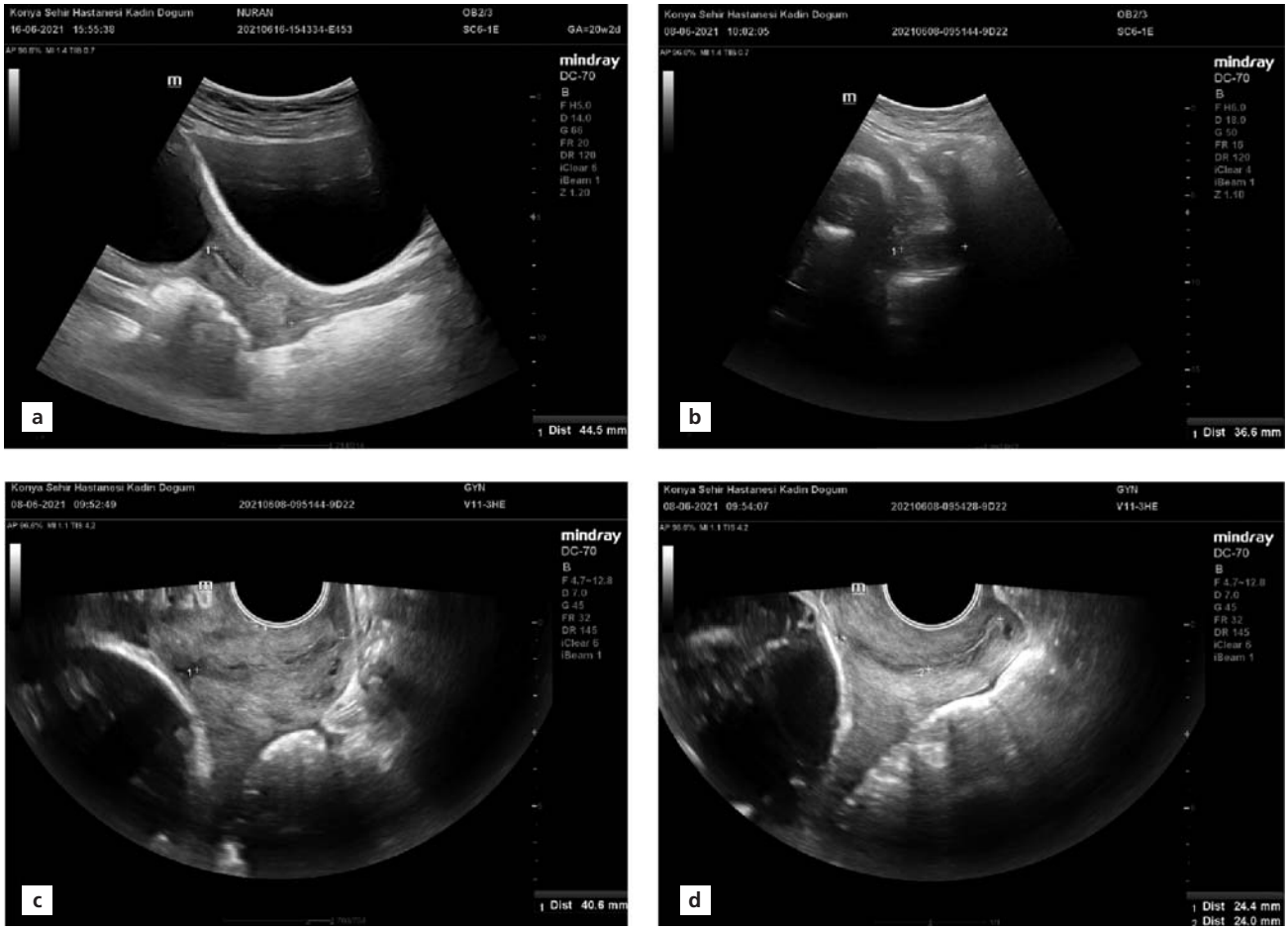

Fig. 1. Sonographic images of cervical length measurements. (**a**) Transabdominal measurement with full bladder. (**b**) Transabdominal measurement with an empty bladder. (**c**) Transvaginal measurement. (**d**) Transvaginal two-line measurement.

statistically significant difference in response to a p-value of 0.05 with a power of 80%. The IBM SPSS Statistics version 22.0 software package (IBM Corp., Armonk, NY, USA) was used to analyze the data obtained in the study. The normality of data distribution was tested using histograms, the Kolmogorov–Smirnov test, and the Shapiro-Wilk test. Repeated measures ANOVA, dependent and independent sample t-test were used in the analysis of the data collected in the study. Bonferoni analysis was used for post-hoc analysis. The level of statistical significance was considered $p<0.05$.

Results

From a total of 110 patients, 36 patients were between 11–14 weeks of gestation, 39 were between 15–28, and 35 were between 29–37 weeks of gestation. The mean age of the patients was 26.4±5.5 years, gravida was 3 (range 1–9), parity was 1 (range 0–5) and BMI was 27.5±4.9 kg/m^2.

Cervical length measurements according to weeks of gestation are shown in **Table 1**. The mean cervical length was 45.6±7.0 cm in first-trimester patients, 42.8±7.0 cm in second-trimester patients, and 41.0±8.5 cm in third-trimester patients. Although TV cervical length was longer in all three trimesters, there was no statistically significant difference between TV and TA with full bladder measurements ($p>0.05$). The effect of bladder fullness on TA cervical length measurements was compared according to the weeks of gestation. Post-void TA images were obtained in 97.3% of all patients. It was not possible to obtain TA cervical length measurements in four (11.1%) patients in the first trimester, in three (7.6%) patients in the second trimester, and one (2.85%) patient in the third trimester due to feasibility issues. In terms of TA measurements among the remaining patients, cervical length was found to be statistically significantly longer with a full bladder in all three trimesters ($p<0.05$) (**Table 1**). In the comparison of cervical length on TA ultrasound with an empty bladder and TV ultrasound, TV measurements were found to be statistically significantly longer in each trimester ($p<0.05$).

Table 2 shows the effects of various maternal and fetal conditions on TA and TV cervical lengths. In the total of 102 patients after excluding the ones that were not able to be measured, no statistically significant difference was found in the comparison of TA with a full bladder and TV cervical lengths ($p=0.970$). In all patients, the cervical length was found longer with a full bladder in the TA approach (42.3±8.2 cm vs. 38.5±7.1 cm; $p<0.001$). In the comparison of three ultrasound methods, statistically significant difference was found in all fetal and maternal conditions except nulliparous patients. It was found that TA with a full bladder and TV cervical lengths were similar regardless of presentation, parity, or obesity. It was also found that bladder fullness affected the TA approach in all patients except nulliparous and obese ones and the cervix was measured longer when the bladder was full in these patients. The results for fetal presentation, parity, and obesity showed that TV cervical length was found significantly different from TA cervical length when the bladder was empty. The discrepancy between the two methods was not affected by presentation, parity or obesity ($p=0.202$, 0.414 and 0.570, respectively).

Discussion

In our study, we investigated the discrepancy between TA and TV cervical length measurements in three trimesters and the effect of bladder fullness on TA measurements. Although TV cervical length was found to be longer in each trimester, there was no difference between TV and TA assessments with a full bladder. It was observed that the cervical length measured longer in pre-void than in post-void TA assessments in each trimester. Factors affecting cervical length measurements such as presentation, parity, and obesity did not affect the ultrasound method.

Accurate and timely diagnosis of preterm labor enables interventions to improve neonatal outcomes such as antenatal steroid administration, prophylaxis for group B streptococci, and magnesium therapy for neuroprotective effects. Short cervical length detected before the 24th week is the strongest evidence of the risk of preterm delivery,[16] and because the cervical effacement starts from the internal os and continues to the caudal, a short cervix is often first diagnosed with ultrasound. By measuring the cervical length at the beginning of the second trimester of pregnancy, high-risk patients can be identified and intervention or progesterone treatment can be decided. There are different recommendations from international organizations about whether cervical length screening should be universal or limited to patients with a short cervix. The Society for Maternal-Fetal Medicine (SMFM) recommends screening singleton pregnant women with a his-

Table 1. Comparison of cervical length measurement techniques according to the weeks of gestation.

Week of gestation	Ultrasound method	n	Mean (cm)	p^a-value	p^1-value	p^2-value	p^3-value
11–14 weeks	TV	36	45.6±7.0	**0.042**	>0.9	**0.022**	**0.031**
	TA.bf	36	44.6±6.7				
	TA.be	32	41.1±5.9				
15–28 weeks	TV	39	42.8±7.0				
	TA.bf	36	41.8±8.6	**<0.001**	>0.9	**0.003**	**<0.001**
	TA.be	36	37.4±7.2				
29–37 weeks	TV	35	41.0±8.5				
	TA.bf	35	39.6±8.3	**0.003**	0.716	**0.046**	**<0.001**
	TA.be	34	37.2±7.4				

p^a: Among the transvaginal measurement, transabdominal measurement with a full bladder and transabdominal measurement with an empty bladder; p^1: between transvaginal measurement and transabdominal measurement with a full bladder; p^2: between transabdominal measurement with a full bladder and transabdominal measurement with an empty bladder; p^3: between transvaginal measurement and transabdominal measurement with an empty bladder. Bold values represent statistical significance (p<0.05). **TA.be:** transabdominal measurement with an empty bladder; **TA.bf:** transabdominal measurement with a full bladder; **TV:** transvaginal measurement.

tory of preterm labor with TV ultrasound at 16–24 weeks, but it does not recommend universal screening.[4] The American Society of Obstetrics and Gynecology (ACOG) recommends screening with TV ultrasound for high-risk patients at the beginning of the second trimester, but it leaves universal scanning to the practitioner's discretion.[10] The International Federation of Gynecology and Obstetrics (FIGO) recommends routine TV cervical length scanning for all pregnant women between 19–24 weeks.[17] Although cervical length measurement is not routinely recommended in the third trimester,[4] it can be used in patients with a short cervix and in estimating the mode or time of delivery.[18] In our study, we aimed to compare cervical lengths measured using TA and TV ultrasound during three trimesters. Thus, we had the opportunity to investigate the effects of anatomic and positional changes related to pregnancy in the uterus and cervix on the ultrasound methods, separately in each trimester.

The cervix is not a static structure throughout pregnancy. With ultrasound, the appearance of the cervix may vary according to the trimesters. In the first trimester, the myometrium, which forms the uterine isthmus, is hypertrophied and it appears as a continuation of the endocervical canal with ultrasound. In this case, the cervix can be measured longer in TA ultra-

Table 2. Mean cervical lengths and discrepancy between transabdominal and transvaginal cervical assessment for each fetal and maternal condition.

	Ultrasound method								
	TV (cm)	TA (cm) Bladder full	TA (cm) Bladder empty	Discrepancy (cm)	p^a-value	p^1-value	p^2-value	p^3-value	p^4-value
Total (n=102)	42.7±7.7	42.3±8.2	38.5±7.1	0.73±1.1	**<0.001**	0.970	**<0.001**	**<0.001**	-
Vertex (n=48)	40.1±7.2	40.4±8.2	36.7±7.2	-0.47±7.1	**<0.001**	>0.9	**0.008**	**<0.001**	0.202
Breech (n=54)	45.0±7.5	43.9±7.8	40.2±6.6	1.73±10.2	**<0.001**	>0.9	**<0.001**	**<0.001**	
Nulliparous (n=32)	41.2±9.0	39.2±8.2	37.0±7.7	2.0±2.0	0.092	-	-	-	0.414
Multiparous (n=70)	43.4±6.9	43.7±7.8	39.1±6.7	0.2±7.2	**<0.001**	>0.9	**<0.001**	**<0.001**	
Obese (n=27)	44.8±7.9	42.9±9.4	40.9±7.6	1.6±7.8	**0.042**	0.692	0.763	**0.008**	0.570
Normal weight (n=75)	41.9±7.5	42.0±7.7	37.6±6.7	0.4±9.3	**<0.001**	>0.9	**<0.001**	**<0.001**	

p^a: among the transvaginal measurement, transabdominal measurement with a full bladder and transabdominal measurement with an empty bladder; p^1: between transvaginal measurement and transabdominal measurement with a full bladder; p^2: between transabdominal measurement with a full bladder and transabdominal measurement with an empty bladder; p^3: between transvaginal measurement and transabdominal measurement with an empty bladder; p^4: comparison of the discrepancy between transvaginal and transabdominal measurement with a full bladder in each group of fetal and maternal condition. The bold values represent statistical significance (p<0.05). **TA:** transabdominal measurement; **TV:** transvaginal measurement.

sound.[19–21] As the week of gestation progresses, this area forms the lower uterine segment and only the endocervical area becomes visible with ultrasound. It is important to distinguish between the isthmus and endocervical canal for accurate measurement of cervical length. The shadow of the fetal presenting part, especially in the third trimester, may mask the internal cervical os, and bladder fullness or small uterine contractions may cause a shorter measurement than the real cervical length with TA ultrasound.[8,9]

Although some studies claimed that TV ultrasound was superior to TA ultrasound in cervical length assessment because it was not affected by maternal obesity, the position of the cervix or the shadow of the presenting fetal part, other studies showed that there was no difference between the two methods. Roh et al.[1] found no difference between TA and TV methods in cervical length measurement in a study that was conducted on pregnant women in the second trimester. Similarly, in two studies that were conducted on patients in the second and third trimesters comparing TV and TA with a full bladder, no difference was found between the two methods.[14,22] We also found no difference between TA assessment with a full bladder and TV assessment in all three trimesters. The fact that the study group consisted of low-risk patients, the bladder fullness was standardized, cervical length was measured by one practitioner, and the superior quality of the ultrasound device may have contributed to our results. It is known that cervical length progressively shortens during pregnancy.[12] In our study, we found the longest mean cervical length in first-trimester patients and the shortest in third-trimester patients. As a result of literature showing that TA ultrasound overestimates the cervix, especially in patients with a cervix of 25 mm and shorter in the second trimester, TV ultrasound seems to be more reliable in these patients.[8,9,13,23,24] We could not find the opportunity to evaluate patients with a short cervix because our patient population consisted of low-risk pregnancies.

It is known that bladder fullness makes the endocervical canal more visible in TA ultrasound.[12] On the other hand, there are studies showing that an overfilled bladder may press and lengthen the cervix and thus lead to an overestimation of TA cervical length measurements.[12,13] In the study conducted by Andersen, the author reported that the feasibility of the TA approach was 46% when the bladder was empty at 6 to 40 weeks of gestation, and this rate increased to 96% with a full bladder.[12] In another study, this rate was reported 51% in third-trimester patients and 80% in second-trimester patients.[11] In our study, we were able to measure TA when the bladder was empty in 97.3% of all patients. The TA cervical length was longer with a full bladder in each trimester. In the comparison of TV and TA ultrasound with an empty bladder, TV cervix measurements were found longer than in the TA approach. Based on our data and previous studies, bladder fullness is important in TA assessments. In the study by Roh et al., no relation was found between the maximum vertical depth of the filled bladder and the discrepancy between TA and TV assessment in second-trimester pregnancies.[1] In the SCOPE study, Stone found in nulliparous low-risk pregnancies at 19–20 weeks that the cervix was shorter in TA ultrasound with an empty bladder, and it was concluded that post-void TA ultrasound was reliable even in short cervixes.[24] Similarly in another study, no difference was found between TA and TV cervical measurements performed with an empty bladder at pregnant women at 31–34 weeks. The authors stated that post-void TA ultrasound could only be performed in 51% of patients and the results could not be generalized in every trimester of pregnancy because the study only included third-trimester patients.[11] In our study, we analyzed patients according to their bladder status and both nulliparous and multiparous patients from three trimesters were enrolled in the study. This can explain the different results from previous studies.

Maternal and fetal conditions such as maternal age, parity number, obesity, maternal pelvic bone structure, fetal presentation, the relation with presenting fetal part and the internal os, which may affect the visualization of the cervical canal, have been studied in the literature.[1,11,12] In a study conducted by Anderson, it was found that multiparous pregnant women had 4 mm longer cervical lengths than nulliparous women.[12] In the study of Roh et al., the authors showed significant discrepancies in cervical lengths between the two methods in primiparous patients and when a fetal presenting part overlay the internal os and when only the internal os was visible on TA ultrasound.[1] Regarding the feasibility of the TA technique, it has been shown that in third-trimester pregnancies, it was less likely to measure cervical length on TA ultrasound in cases with a vertex fetal presentation.[11] In our study, we found a significant difference among the three methods in different maternal and fetal conditions. In post-hoc analysis, it was found that the cervical length was measured significantly shorter with TA ultrasound

when the bladder was empty. We found no significant difference between the TV and TA with a full bladder according to the presentation, parity, and obesity. Although the cervix was measured longer in multiparous patients compared with nulliparous patients in both methods, no statistically significant correlation was revealed. There are studies in the literature that support our result that there is no relationship between parity and cervical length.[25,26] In all patients, except nulliparous patients and those with obesity, the cervix was measured longer in the TA assessment when the bladder was full compared with when the bladder was empty. The low feasibility of measuring the cervix with TA ultrasound in patients with obesity and shorter cervixes of nulliparous patients compared with multiparous patients may have affected our results. Factors that cause the cervix to be measured incorrectly in cervical length measurements are situations such as excessive pressure on the ultrasound probe during measurement, the presence of uterine contractions, and the inability to differentiate the lower uterine segment from the cervix in first trimester pregnancies. In our study, the measurements were conducted by a single practitioner using the same technique and the study group consisted of low-risk patients. This may have caused the cervix to be optimally measured and caused the lack of difference between the two methods.

Our study has some strengths and limitations. Measurements were conducted by the same person, which eliminated interobserver variations. The feasibility of the TA approach with an empty bladder was high in this study compared with previous studies. Also, the study group consisted of patients from every trimester. The investigation of the effect of bladder fullness and various maternal/fetal conditions with both TA and TV ultrasound are the strengths of this study. This study was conducted on a small number of patients and it was a single center's experience. Also, we could not compare the methods in patients with short cervixes.

Conclusion

TA ultrasound can be reliably preferred in low-risk pregnant women in evaluating cervical length. Afterwards, measurements can be performed using TV ultrasound. This stepwise approach seems more beneficial and applicable for both patients and physicians. Bladder fullness is important in TA assessments of cervical length.

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Compliance with Ethical Standards: The authors stated that the standards regarding research and publication ethics, the Personal Data Protection Law and the copyright regulations applicable to intellectual and artistic works are complied with and there is no conflict of interest.

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