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Transabdominal and transvaginal ultrasound assessment of cervical length — can transvaginal approach be avoided?

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ABSTRACT

Objectives: This study aimed to compare transabdominal (TA) and transvaginal (TV) ultrasound assessment of cervical length during pregnancy and to establish cervical length above which transvaginal measurement is not necessary.

Material and methods: Cervical length was measured using TA and TV method in the first (11 + 0–13 + 6 weeks), the second (20 + 0–21 + 6 weeks) and the third trimester (28 + 0–31 + 6 weeks) in 250 women with singleton pregnancy and low risk for preterm birth.

Results: If the cervical length measured in the second trimester of pregnancy with transabdominal approach is ≥ 28.5 mm and ≥ 30.5 mm in the third trimester, it can be assumed with 100% sensitivity the cervical length measured with transvaginal method will be > 25 mm. Transabdominal cervical length measurement in the second and third trimester allows 89% and 65% of patients, respectively, to avoid transvaginal scan.

Conclusions: Second and third trimester screening by transabdominal cervical length measurements in a group of pregnant women with low risk for preterm birth is useful to determine which patients require transvaginal measurement.

Key words: cervical length measurement; transabdominal ultrasonography; transvaginal ultrasonography; preterm delivery

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INTRODUCTION

Preterm delivery invariably remains the biggest, unsolved problem of perinatal medicine [1]. It is estimated that the problem of preterm delivery affects 9.6% of births worldwide. Despite the huge progress that has been made in recent decades, the incidence of preterm births has not been significantly reduced [1]. However, a number of actions are undertaken to not only implement medical procedures or drugs that reduce the number of preterm births [2], but also to identify a group of patients at high risk of this complication. An important step towards achieving this goal was the introduction of ultrasound cervical length assessment and new biochemical methods [3]. Studies have confirmed that the shorter the cervix, the greater the risk of preterm birth [4] and this relationship is further compounded if there were preterm births in the past and the mother is at an advanced age [5].

Transvaginal cervical length measurement at 18–24 weeks of singleton pregnancy is currently considered the best way to assess the risk of preterm delivery. This method has been well described in published studies and has the recommendations of most scientific societies in the world [6, 7]. Nevertheless, the transabdominal ultrasound assessment of cervical length also seems to correlate well with transvaginal measurements. In the United States in 2015, a national survey on the frequency of using cervical length screening in the general population showed that 32% of pregnant women did not have a cervical length measurement. Transvaginal cervical length measurement was performed in 32% of pregnant women and was used

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mostly in clinical sites. However, transabdominal cervical screening was performed most often (36%) [8]. Therefore, it seems advisable to develop an effective population screening model for preterm delivery - using both transvaginal and transabdominal measurements. Widespread cervical length screening in a low-risk population is an important element in preventing preterm delivery, as confirmed by randomized clinical trials that showed a 45% reduction in the risk of preterm delivery in women with the short cervix after vaginal progesterone administration [2, 9]

The objective of this study was to compare methods of transabdominal and transvaginal cervical length measurement during routine ultrasound scans in the first trimester (11 + 0–13 + 6 weeks), in the second trimester (20 + 0–21 + 6 weeks) and in the third trimester (28 + 0–31 + 6 weeks) of pregnancy in a population at low risk of premature delivery. An attempt was made to correlate the cervical length by transabdominal scan which can predict a transvaginal cervical length of 25 mm and less.

Objectives

This study aimed to compare transabdominal (TA) and transvaginal (TV) ultrasound assessment of cervical length during pregnancy and to establish cervical length above which transvaginal measurement is not necessary.

MATERIAL AND METHODS

From April 2016 to August 2018, the study covered two hundred and fifty (n = 250) women with singleton pregnancy. Each patient underwent three ultrasound scans: in the first trimester (11 + 0–13 + 6 weeks), in the second trimester (20 + 0–21 + 6 weeks) and in the third trimester (28 + 0–31 + 6 weeks). In addition, during each scan, transabdominal and transvaginal cervical length measurements were made after emptying the bladder. The study population was a group of pregnant Caucasian women without a positive history of premature delivery. The study inclusion criteria were live singleton pregnancy and no symptoms of threatening preterm delivery. Patients qualified for the study received a questionnaire to fill with questions regarding demographic data and obstetric history. The results regarding delivery and the newborn are derived from post-delivery medical records. All ultrasound scans were performed using a Voluson S6 apparatus (GE Healthcare, Kretztechnik, Austria), convex C1–5RS head, 2-5 MHz, and E8C–RS vaginal head, 4-10 MHz by one operator certified by the Fetal Medicine Foundation (FMF) (*Certificate of Competence in Cervical Assessment*). Transvaginal cervical length measurement was performed in accordance with the FMF guidelines [10], while transabdominal cervical length measurement was performed after modification of the FMF guidelines according to Lisa Saul [11]. The scoring of cervical visualization was based on the visualization of the landmarks described (no visualization, moderate visualization or excellent visualization). The image was considered sufficient for evaluation if at least three landmarks were revealed. The optimal image is one in which four or more landmarks were successfully visualized. (Fig. 1).

Patients were asked to empty their bladders before the study. In order to obtain precise results of transabdominal cervical length measurement, in addition to visualizing at least three landmarks, it was necessary to visualize the internal orifice of the cervix.

Statistical analysis

For normal distribution, the values of variables between the groups were compared by Student's t-test and one-way ANOVA with Duncan's post-hoc test, and for non-normalized variables, by non-parametric analysis of variance tests: Mann-Whitney-Wilcoxon or Kruskal-Wallis. The correlation

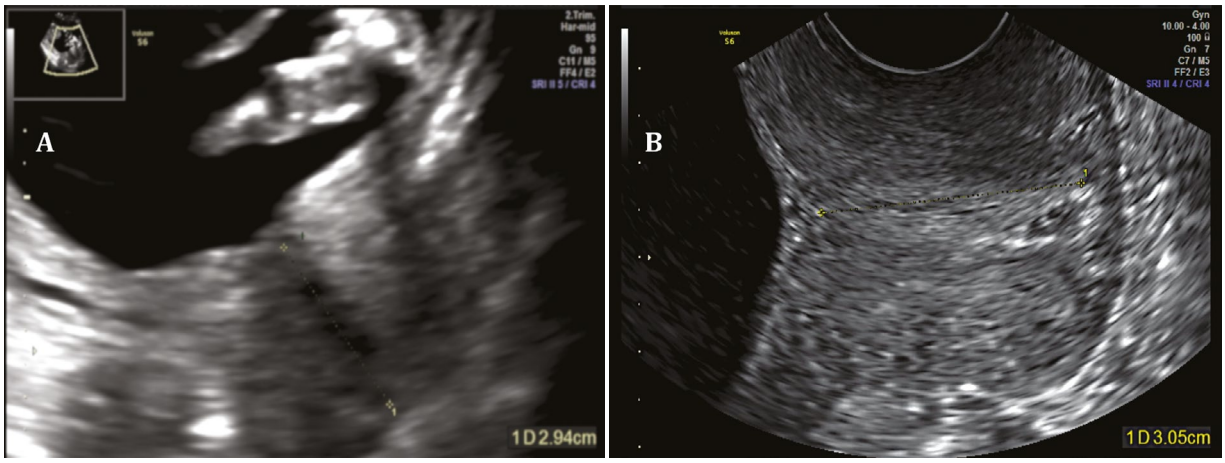

Figure 1. Cervical length measurement in the same patient taken with two different methods at 20 weeks of gestation; **A.** Transabdominal measurement (cervical length: 29.4 mm); **B.** Transvaginal measurement (cervical length: 30.5 mm)

study was conducted using Pearson or Spearman correlation analysis. The receiver operating characteristic (ROC) logistics curve was used to evaluate the usefulness of transabdominal cervical length measurement in recognizing a cervical length shorter than 25 mm by transvaginal scan. The area under the area under curve (AUC) with the confidence interval and coordinates of the ROC curve points was calculated.

Sensitivity, specificity as well as positive and negative predictive values for excluding a cervical length less than 25 mm were calculated for selected cut-off points of cervical length measured by transabdominal scan. The p value < 0.05 was adopted as statistically significant. The SPSS 15.0 statistical package was used for the calculations.

RESULTS

The study included 250 patients qualified in the first trimester of pregnancy. Two patients were excluded from the study due to fetal anatomical defects at the later stages of pregnancy. Three patients had a miscarriage after the 12th week of pregnancy (study group in the second trimester n = 245). Moreover, between the second and third trimester, measurement data were not collected in five patients (study group in the third trimester n = 240). The median age at study enrolment was 30 years. The median of body mass index (BMI)in the study group was 23.57. The demographic characteristic of the study population is described in Table 1.

Cervical length in transabdominal (TA) and transvaginal (TV) measurements in three trimesters of pregnancy is presented in Table 2.

Analysis of the area under the ROC curve showed that the values of cut-off point of the cervical length measured by transabdominal scan in the second trimester of pregnancy (28.5 mm) are characterized by high sensitivity in excluding a cervical length < 25 mm measured by transvaginal scan (area under the ROC graph 0.995) (Fig. 2). The optimal balance was found between high sensitivity (100%) and specificity for the cut-off point of 28.5 mm in transabdominal measurement.

Sensitivity and specificity as well as the positive and negative predictive value of the cut-off point of cervical length measured by transabdominal scan in the second trimester of pregnancy (> 28.5 mm) in predicting a cervical length < 25 mm measured by transvaginal scan (Tab. 3).

Analysis of the area under the ROC curve showed that the values of cut-off point of the cervical length measured by transabdominal scan in the third trimester of pregnancy (> 30.5 mm) are characterized by high sensitivity in excluding a cervical length < 25 mm measured by transvaginal scan (area under the ROC graph 0.995) (Fig. 3). The optimal balance was found between high sensitivity (100%) and specificity for the cut-off point of 30.5 mm in transabdominal measurement. Based on the analysis of individual points of the ROC curve, the cut-off point of cervical length meas-

Table 1. Demographic characteristic of the study population

	Mean ± SD	Median	IQR	Range
Body weight [kg]	68.3 ± 14.0	65	53.2–76	41.6–119.8
Height [cm]	166.7 ± 6.2	166	163–171	154–182
Age [years]	30.9 ± 4.1	30	27–33	21–41
BMI	24.6 ± 4.7	23.5	21.2–27.3	17.1–41.1

BMI — body mass index; IQR — interquartile range; SD — standard deviation

Table 2. Cervical length measurements made by transabdominal (TA) and transvaginal (TV) scan

Number of patients	n = 248		n = 245		n = 240	
CL [mm]	1st trimester		2nd trimester		3rd trimester	
TA/TV	TA	TV	TA	TV	TA	TV
Min	**28.0**	25.4	18.0	15.0	12.0	6.3
5 centile	30.2	31.0	28.0	28.3	25.9	24.0
25 centile	35.0	36.0	33.0	34.0	30.0	32.0
50 centile	38.3	38.8	36.0	38.3	34.0	35.0
75 centile	40.0	42.0	39.0	40.5	37.4	39.0
95 centile	43.0	46.0	42.0	44.0	41.0	42.0
Max	49.0	53.0	48.0	50.0	54.0	46.4
Mean (SD)	37.7 (3.8) *	38.8 (4.6) *	35.8 (4.4) **	37.2 (5.2) **	33.7 (4.9) ***	34.4 (5.6) ***

TA — transabdominal cervical length measurement; TV — transvaginal cervical length measurement; CL — cervical length (mm); SD —s tandard deviation; *TA vs TV in the first trimester — p < 0.0001; **TA vs TV in the second trimester — p < 0.0001; ***TA vs TV in the third trimester — p = 0.09

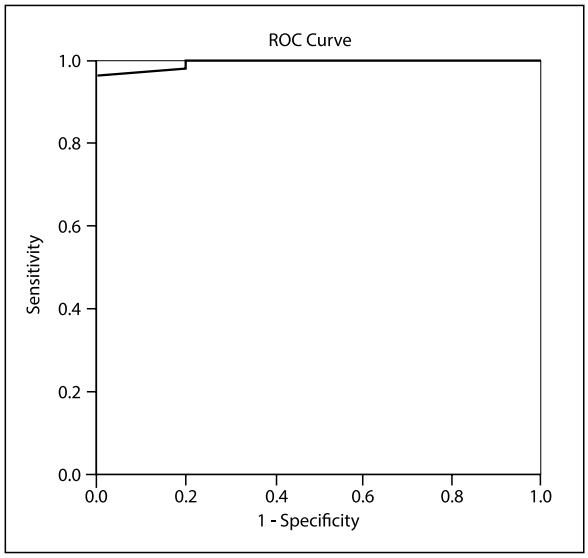

Figure 2. The receiver operating characteristic (ROC) curve graph for transabdominal cervical length measurement in excluding a cervical length less than 25 mm measured by transvaginal scan in the second trimester of pregnancy (AUC = 0.995)

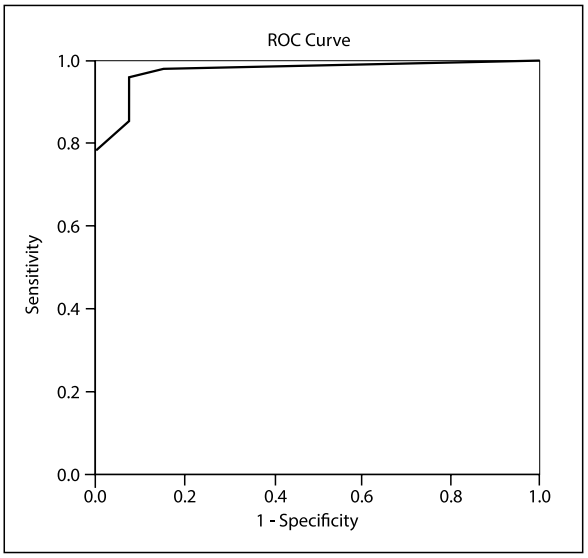

Figure 3. The receiver operating characteristic (ROC) curve graph for transabdominal cervical length measurement in excluding a cervical length less than 25 mm measured by transvaginal scan in the third trimester of pregnancy (AUC = 0.978)

Table 3. Sensitivity and specificity as well as the positive and negative predictive value of the cut-off point of cervical length measured by transabdominal scan in excluding a cervical length less than 25 mm measured by transvaginal scan in the second trimester of pregnancy

	Cervical length (TA) < 28.5 mm
Sensitivity [%]	100
Specificity [%]	96.5
PPV [%]	38.5
NPV [%]	100

PPV — positive predictive value; NPV — negative predictive value

Table 4. Sensitivity and specificity as well as the positive and negative predictive value of the cut-off point of cervical length measured by transabdominal scan in excluding a cervical length less than 25 mm measured by transvaginal scan in the third trimester

	Cervical length (TA) < 30.5 mm
Sensitivity [%]	100
Specificity [%]	78
PPV [%]	22.4
NPV [%]	100

PPV — positive predictive value; NPV — negative predictive value

ured by transabdominal scan in the third trimester of pregnancy (30.5 mm) was chosen, characterized by high sensitivity in predicting a cervical length less than 25 mm in transvaginal measurement.

Sensitivity and specificity as well as positive and negative predictive value of the cut-off point of cervical length measured with transabdominal method in predicting a cervical length < 25 mm measured with transvaginal scan (Tab. 4).

DISCUSSION

Only effective population screening, which will not be limited to pregnant women at high-risk of premature delivery, but will also include pregnant women at low-risk of premature delivery, can have a significant impact on reduction in the percentage of preterm births, because as much as 93% of all preterm births occur in this group [12]. Transvaginal scan is uncomfortable, and many patients decline this scan. In this study we aimed to measure cervix transabdominally and tried to find out a value which would predict a cervical length of 25 mm by transvaginal scan, as a cervical length of 25 mm is predictive of preterm birth.

Based on the results obtained, it can be assumed that if transabdominal cervical length measurement in the second trimester of pregnancy is above 28.5 mm, then with 100% sensitivity a cervix shorter than 25 mm can be excluded in transvaginal scan. This allows 89% of patients to avoid transvaginal ultrasound. Nevertheless, to ensure high sensitivity of transabdominal screening measurement, in 11% of patients it will be necessary to perform transvaginal ultrasound scan.

If transabdominal cervical length measurement in the third trimester of pregnancy is above 30.5 mm, then with 100% sensitivity a cervix shorter than 25 mm can be excluded in transvaginal scan. Transabdominal cervical length measurement in the third trimester allows 65% of patients to avoid transvaginal ultrasound to exclude a cervix shorter than 25 mm. To ensure a high sensitivity of transabdominal

Table 5. A summary of data comparing transabdominal (TA) and transvaginal (TV) cervical length measurement in studies by various authors

Study author	GA [week]	Size of the study group [CL TV < 25 mm]	Bladder condition in screening CL–TA	Assessment TA/TV blinded	Cut-off value for TA method	Mean CL TA [mm]	Mean CL TV [mm]	CL TA longer/ shorter than TV	TA–TV difference [mm]
Andersen et al. 1990 [19]	< 30	125	full	no	–	46.8	40.9	longer	5.9
Andersen et al. 1991 [20]	6–40	186	empty	no	–	43.7	41.6	longer	2.1
To et al. 2000 [21]	22–24	149	full	–	–	34	37	shorter	–3
Saul et al. 2008 [11]	14–34	191 (14)	empty	yes	< 30	35.7	36.1	similar	–0.4
Stone et al. 2010 [22]	18–20	203	empty	no	–	36.6	39.1	shorter	–2.5
Hernandez-Andrade et al. 2012 [23]	6–39	220 (20)	full	yes	< 25 < 30	34.6	34.8	similar longer	–0.2
Fridman et al. 2013 [13]	18–24	1217 (76)	full empty	no no	≤ 26 ≤ 36	33.5	36.1	shorter	–2.6
Roh et al. 2013 [24]	20–30	475	empty	no	< 27	38.8	39.3	similar	–0.5
Marren et al. 2014 [18]	18–20	198 (13)	full empty	no no	< 30 < 25	33.3 33.7	39.2 33.1	longer similar	6.0 0.6
Pandipati S et al. 2015 [14]	18–23	1580	empty full	no	≤ 35 ≤ 36	39.8 39.0	41.8 41.2	shorter shorter	–2.0 –2.2
Peng C R et al. 2015 [17]	20–24	174	empty	no	< 29	36.0	37.6	shorter	–1.6
Westerway et al. 2015 [15]	16–41 16–23 24–35 > 36	491 335 139 17	full	no	< 25	33 33.6 32.1 27.9	35 36.2 33.1 25.6	shorter shorter shorter longer	–2.0 –2.7 –1.0 2.3
Rhodes et al. 2016 [16]	17–23	404	empty	no	≤ 35	38.5	42.3	shorter	–3.8
Cho et al. 2016 [25]	20–29	771	empty/full	no	–	37.8	38.2	similar	–0.4
Puttanavijarn et al. 2017 [26]	16–23	160	empty	no	< 30	36.4	41.2	shorter	–4.8
Korniluk 2020	11–14 20–22 28–32	250 247 (4) 242 (10)	empty	no	< 25	37.7 35.8 33.7	38.8 37.2 34.4	shorter shorter shorter	–1.1 –1.4 –0.7

GA — gestational age (weeks); CL — cervical length (mm); TV — transvaginal scan TA — transabdominal scan

screening, in 35% of patients it will be necessary to perform a transvaginal ultrasound scan in the third trimester.

The values of the calculated cut-off points are similar to those presented in other publications, where the described range of values is between 29 mm and 36 mm [13–17]. Only in the study by Marren et al. [18], due to the inability to achieve optimal sensitivity (15.4%) and specificity (93.2%), the authors were unable to determine the cut-off point of cervical length measured by transabdominal scan for predicting a cervical length below 25 mm measured by transvaginal scan.

In the study group, the mean cervical length of the cervix measured with the transabdominal method was consistently smaller than those measured by transvaginal scan (Tab. 1). This observation is also consistent with other studies (Tab. 5).

Some authors have found that there are no statistically significant differences between the cervical length measured by transvaginal and transabdominal scan [11, 24, 25]. The longer cervix in transabdominal scan compared to transvaginal scan was observed when measuring with a full bladder (Tab. 5), [18, 19] and in the third trimester

over 36 weeks of pregnancy [15], as well as with a short cervix (< 25 mm) (Tab. 2) [15, 23, 27].

In the study group, the greatest cervical shortening was observed in the third trimester of pregnancy both in transvaginal measurement (10.8%) and in the transabdominal measurement method (6.2%). In the literature, a considerable shortening of the cervix (even above 20 mm) is usually observed after 32 weeks of pregnancy [28] and is usually associated with the maturation of the vaginal part of the cervix for delivery. The data obtained are consistent with the study results by other authors [15, 29, 30]. There is also evidence of a linear cervical shortening after 24 weeks of pregnancy, with the cervical length decreasing by 0.74 mm per week in transvaginal assessment [15].

The study also found that the cervical length showed minimal changes between the first trimester and the second trimester in both transabdominal (5%) and transvaginal (4.3%) scan, which is confirmed by most literature data [30, 31]. For this reason and due to the lack of patients in the first trimester with the cervix shorter than 25 mm, no ROC curves were determined for the study between 11–13 weeks of pregnancy.

The study group also showed that cervical shortening during the three trimesters of pregnancy is greater in transvaginal assessment (15.1%) than in the transabdominal measurement method (11.2%), due to overestimation of the cervical length by transabdominal scan in the third trimester. These observations are consistent with reports from the literature [15].

In the studies by other authors, the percentage of patients who need transvaginal reassessment of the cervix differs and depends on the visualization of the cervix and the percentage of short cervix found by transabdominal ultrasound in each population [13, 14, 16, 25].

Numerous studies have shown that progesterone administration effectively reduces the risk of spontaneous premature delivery in women with the short cervix in the second trimester of pregnancy [2, 9, 32]. However, the percentage of women meeting the criteria for implementing this prevention in the general population is relatively small [4, 33, 34]. Identification of these women requires a routine transvaginal cervical length measurement during fetal examination in the second trimester, which increases the time and costs of the examination and creates additional discomfort for the patient. Considering the high costs associated with preterm delivery and the savings obtained with its prevention, it has been found that the common transvaginal measurement of cervical length is economically justified in groups at high-risk of preterm delivery, but has limited rationale in groups at low-risk of preterm delivery [35]. However, since the majority of preterm deliveries occur in the low-risk group, it seems appropriate to use the transabdominal measurement of cervical length during routine ultrasound scans in the second trimester of pregnancy, and to use a cut-off point below which the risk of a short cervix (< 25 mm) is extremely low. Doing so would increase the number of screenings carried out with greater acceptance by pregnant women and ensure more effective prevention of premature delivery without increasing the cost of the scan [13].

CONCLUSIONS

Second and third trimester screening by transabdominal cervical length measurements in a group of pregnant women with low risk for preterm birth is useful to determine which patients require transvaginal measurement.

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Statement of ethics

All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study protocol has been approved by the Bioethics Committee of Medical University of Warsaw (Statement No: KB 56/2017).

Authors contribution

AK: data acquisition, conception of the work, manuscript writing; PK conception of the work, statistical analysis, manuscript writing, critical review; PD: statistical analysis; MW: conception of the work, statistical analysis; critical review.

Conflict of interest

The authors declare no conflict of interest.

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