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Research Paper

Comparison of Cervical Parameters by Three-Dimensional Ultrasound according to Parity and Previous Delivery Mode

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Abstract

Background: We would like to find out that whether the patient's parity, previous delivery mode and previous labor could influence cervical parameters. Cervical length, volume and width were measured using two-dimensional (2D) and three-dimensional (3D) transvaginal ultrasound on normal pregnant women.

Method: This study was conducted between January 2009 and December 2010 in singleton pregnant women who were admitted for routine antenatal care at hospitals in affiliation with the Catholic University, Seoul, Korea. The study group was classified by parity (nullipara and multipara) and previous delivery mode (cesarean section group and vaginal delivery group). The previous cesarean section group was divided by elective group who did not undergo labor and labor group who underwent labor. Cervical parameters such as cervical length, volume and width were measured using 2D and 3D ultrasound examinations in the first and second trimesters and the results were analyzed between those groups mentioned above.

Results: One hundred and twenty-one pregnant women in their 1st trimester and 233 pregnant women in their 2nd trimester (a total of 354) were enrolled in this study. Cervical parameters were not statistically significant from parity, nor previous delivery mode and previous labor in 1st trimester. Cervical volumes were not statistically significant from nullipara and elective cesarean section groups (35.96±9.81 vs. 34.73±9.75 cm3), but the nullipara groups were significantly lowered in the vaginal group (35.96±9.81 vs. 43.10±11.87 cm3) in 2nd trimester. For the nullipara group, cervical widths were not statistically significant in the elective cesarean section group but these were significantly lower than labor and previous vaginal group in the 2nd trimester.

Conclusion: The cervical volume and width have an influence on parity, previous delivery mode and labor in the 2nd trimester.

Key words: 3D ultrasound, cervical volume, cervical length, cervical width, pregnancy

Introduction

The morphology of the cervix changes during pregnancy or labor and the individual differences are related to intrapartum functional characteristics [1, 2].

Specifically, the morphology of the cervix between nullipara and multipara are different and this is easily recognized in the clinical field. These differences may

be due to microscopical changes in the content of water, elastin, collagen, etc., of the cervix tissues [1, 3]. The cervical differences could cause different intrapartum cervical progression between nullipara and multipara. Cervical morphology and volume are more easily and accurately determined by a 3D ultrasound when compared to conventional 2D ultrasound [4-7]. However, many studies which research cervical changes during pregnancies, often use 2D ultrasound [1, 8, 9]. Although there have been a number of recent studies using 3D ultrasound to determine cervical volume [10, 11], this number may be considered insufficient.

In this study, we measured the cervical length, volume and width using both, a 2D and 3D ultrasound in pregnant women and compared these results to the patient's parity, previous delivery mode and previous labor.

Methods

This study was conducted between January 2009 and December 2010 in healthy singleton pregnant women, who had received routine antenatal care at the Department of Obstetrics, Catholic University Saint Vincent's Hospital. Transvaginal sonographic evaluation of the cervixes was performed when measuring nuchal translucency in the 1st trimester and when measuring the fetal anatomical structures in the 2nd trimester. At this time, we were measuring cervical length, volume and width as well. This study was approved by the Institutional Review Board (VC11RIS0129). Women with history of cervical conization, uterine malformation, cervical incompetence, painful regular uterine contractions and history of preterm delivery were excluded. Sonographic examinations were performed with a 3-8 MHz 3D vaginal transducer (ACCUVIX XQ-3D, Medison, Seoul, Korea). Pregnant women were examined in the dorsal lithotomy position with an empty bladder. Cervical length was measured from external os to internal os along the cervical canal. If the cervical canal was not in a straight line, the cervical length was divided into two or more lengths and added together. Cervical width (the distance from anterior to posterior cervix, perpendicular to the midline of endocervical canal) was also measured. After measuring cervical length and width (to determine cervical volume), the same transvaginal probe was changed to 3D mode. The cervix was then scanned by 3D mode and divided into fifteen parallel sections. Each sectional plane was manually drawn using the roller ball cursor of the system. Once all contours had been drawn, the volume of the cervix was calculated automatically. All sonographic examinations were performed by the same operator.

Clinical information such as maternal age, parity, previous delivery mode and previous delivery events were gathered from medical records. According to parity, patients were divided into nullipara and multipara groups. Then the multipara groups were further classified by the delivery mode into 'previous cesarean section group' and 'previous vaginal delivery group'. Again, the previous cesarean section group was classified by those who underwent labor (labor group) and those who did not (elective group).

All statistical analyses were performed by SAS version 8 (SAS institute Inc, Cary, USA). An unpaired t-test was used to compare the demographic characteristics and cervical parameters of nullipara and multipara in 1st and 2nd trimesters. A one-way ANOVA was also used to compare demographic characteristics and cervical parameters of each group. All values were indicated as mean +/- SD. Maternal age and the estimated gestational weeks were described as a range. $p < 0.05$ was used to determine statistical significance.

Results

General characteristics

One hundred and twenty-one women in the 1st trimester and 233 women in the 2nd trimester, totaling 354 women participated in this study. Of 1st trimester participants, 41and 80 participants were considered as nullipara and multipara, respectively. Of 2nd trimester participants, 88 and 145 were considered nullipara and multipara, respectively. Multipara women were all older than nullipara women in both 1st and 2nd trimesters (p<0.05). The mean gestational ages on performed ultrasound examinations were 11.25±0.75 weeks in 1st trimester and 23.07±2.37 weeks in the 2nd trimester. There were no significant differences between parity, previous delivery mode or labor (Table 1, Table 2).

Differences of cervical parameters in 1st trimester and 2nd trimester

The average cervical length in 1st trimester group was significantly longer than that of the 2nd trimester group (4.08±0.72 vs. 3.89±0.85cm, p=0.041). The average cervical volume in 2nd trimester group was significantly greater than that of 1st trimester group (39.29±11.18 cm3 vs. 31.42±12.12 cm3, p<0.001). Average cervical width in the 2nd trimester group was significantly wider than that of 1st trimester group (3.59±0.55cm vs. 3.08±0.49 cm, p<0.001) (Table 3).

Differences of cervical parameters by parity, previous delivery mode and labor

Cervical parameters by parity, previous delivery mode and labor were not statistically significant between 1st trimester groups (Table 1, Table 2). In the 2nd trimester, cervical lengths in: nullipara was 3.92±0.78 cm; multipara was 3.88±0.89 cm; the elective group was 4.00±0.99 cm; the labor group was 3.69±0.74 cm, and the previous vaginal delivery group was 3.89±0.68 cm. These were not significantly different between nullipara and multipara groups (p=0.739). Furthermore, 2nd trimester cervical length parameters were also not significantly different between the elective group, the labor group and previous vaginal delivery group (p=0.204) (Table 2).

Table 1. Comparison of maternal demographic characteristics and cervical parameters according to parity

		Nullipara	Multipara	*p*-value
1st trimester	N	41	80	
	Age(years)	30.56±5.24 (20-40)	33.44±3.58 (27-38)	0.003
	Gestational age (weeks)	11.29±0.72 (9.1-12.6)	11.24±0.78 (8.3-13.1)	0.732
	Cervix length (cm)	4.00±0.73	4.12±0.71	0.423
	Cervix volume (cm^3)	32.19±12.8	31.0±11.7	0.616
	Cervix width (cm)	3.15±0.47	3.05±0.5	0.294
2nd trimester	N	88	145	
	Age(years)	31.91±3.5 (23-41)	33.54±4.39 (20-41)	0.002
	Gestational age(weeks)	23.43±2.11 (18.4-27.6)	22.84±2.48 (14.1-27.6)	0.066
	Cervix length(cm)	3.92±0.78	3.88±0.89	0.739
	Cervix volume(cm^3)	35.96±9.81	41.30±11.55	0.002
	Cervix width (cm)	3.42 ±0.51	3.7±0.54	<0.001

Values are expressed as mean±SD (range)

N: Numbers

Table 2. Comparison of maternal demographic characteristics and cervical parameters according to previous delivery mode

		Nullipara	Multipara		Previous vaginal delivery	p-value
			Previous cesarean section			
			Elective	Labor		
1st trimester	N	41	12	32	36	
	Age(years)	30.56±5.24[a] (20-40)	36.5±2.68[ab] (33-40)	34.16±3.38[bc] (27-41)	31.78±3.19[c] (27-38)	0.001
	Gestational age (weeks)	11.29±0.72 (9.1-12.6)	11.47±0.51 (11-12.4)	11.38±0.46 (10.4-12.3)	11.03±1.0 (8.3-13.1)	0.174
	Cervix length (cm)	4.00±0.73	4.41±0.7	4.02±0.91	4.1±0.45	0.366
	Cervix volume (cm^3)	32.19±12.8	30.74±16.07	30.64±9.99	31.44±11.95	0.954
	Cervix width (cm)	3.15±0.47	2.85±0.62	3.1±0.43	3.06±0.47	0.319
2nd trimester	N	88	18	46	82	
	Age(years)	31.91±3.5[a] (23-41)	34.17±4.95[b] (20-42)	34.85±4.09[b] (20-42)	32.55±4.35[a] (23-41)	0.001
	Gestational age (weeks)	23.13±2.11 (18.4-27.6)	22.27±3.31 (14.1-27.6)	23.57±2.56 (14.1-26.1)	22.55±2.14 (17.5-27.6)	0.106
	Cervix length (cm)	3.92±0.78	3.89±0.68	3.69 ±74	4.00±0.99	0.204
	Cervix volume (cm^3)	35.96±9.81[a]	34.73± 9.75 [a]	40.64±10.66 [a,b]	43.10±11.87[b]	<0.001
	Cervix width (cm)	3.42 ±0.51 [a]	3.38±0.32 [a]	3.76± 0.49 [b]	3.74± 0.57 [b]	<0.001

Values are expressed as mean±SD (range)

N: Numbers

Elective: Those who did not undergo labor at previous cesarean section

Labor: Those who underwent labor at previous cesarean section

a,b,c: The same letters indicate non-significant difference between groups based on Turkey's multiple comparison test.

Table 3. Comparison of cervical parameters according to trimester

	1st trimester	2nd trimester	*p*-value
N	121	233	
Cervical length(cm)	4.08±0.72	3.89±0.85	0.041
Cervical volume(cm³)	31.42±12.12	39.29±11.18	<0.001
Cervical width(cm)	3.08±0.49	3.59±0.55	<0.001

Values are expressed as mean±SD

N: Numbers

Table 4. Comparison of cervical parameters according to delivery numbers in multipara

		Delivery numbers			*p*-value
		1	2	3	
1st trimester	N	61	15	4	
	Cervix length(cm)	4.13±0.75	3.93±0.58	4.54±0.00	0.269
	Cervix volume(cm³)	32.56±11.55	23.95±10.47	33.92±12.64	0.277
	Cervix width(cm)	3.13±0.45	2.73±0.57	3.04±0.58	0.242
2nd trimester	N	122	24	0	
	Cervix length(cm)	3.92±0.95	3.68±0.46	-	0.386
	Cervix volume(cm³)	41.43±11.66	40.59±10.92	-	0.93
	Cervix width(cm)	3.69±0.54	3.74±0.57	-	0.917

Values are expressed as mean±SD

N: Numbers

In the 2nd trimester, the cervical volume in: nullipara was 35.96±9.81 cm3; multipara was 41.30±11.55 cm3; the elective group was 34.73±9.75 cm3; the labor group was 40.64±10.66 cm3, and the previous vaginal delivery group was 43.10±11.87 cm3. Multipara groups were found to have a larger volume than nullipara groups (p=0.002). The previous vaginal delivery group had a significantly larger volume when compared with the nullipara and elective groups (p<0.001). However, there were no significant differences between the nullipara, elective and labor groups. There were also no significant differences between the labor group and the previous vaginal delivery group (Table 2).

The following 2nd trimester cervical widths were determined: 3.42±0.51 cm for the nullipara group; 3.7±0.54 cm for the multipara groups; 3.38±0.32 cm for the elective group; 3.76±0.49 cm for the labor group and 3.74±0.57 cm for the previous vaginal delivery group. In general, multipara group was found to be wider than the nullipara group (p<0.001). Labor and previous vaginal delivery groups were wider than the nullipara and elective group (p<0.001). Cervical width was not statistically significant between the nullipara and elective group, the labor group and the vaginal delivery group, respectively (Table 1, Table 2).

Influences of cervical parameter on multipara

Cervical parameters measured in 1st and 2nd trimester did not show significant differences as parity increased (Table 4).

Discussion

The use of ultrasound examination in pregnant women is preferred over digital examination because it is more accurate in determining minor progressive cervical changes [12]. It has been revealed from previous studies that the cervical morphology is different during each trimester, labor and parity (via 2D ultrasound). According to Zorzoli et al., the cervix of nullipara and multipara is different however both the cesarean and nullipara groups show similar cervical morphology [1]. Three-dimension ultrasound is better than the 2D ultrasound in measuring the cervical volume [6, 7] however, as the history of 3D use is short, there is a distinct lack in the number of empirical studies describing the use of 3D ultrasound this field. Therefore, studies on the cervical volume during normal pregnancies are insufficient. Recently, there have been attempts to increase the accuracy of the prediction rate of preterm birth not only by measuring the cervical length via the conventional 2D transvaginal ultrasound but also by calculating the cervical

volume using the 3D transvaginal ultrasound [13, 14]. In spite of great efforts, many studies do not show that the cervical volume is more significant than the cervical length [10, 13-15].

In our study, we found cervical length to be significantly shorter in the 2nd trimester than in the 1st. There were no differences in cervical length during each trimester according to parity, previous delivery mode and previous delivery event. This result is in agreement with other studies [1, 9, 16, 17].

Compared to cervical length, cervical volume becomes significantly larger in the 2nd trimester than in the 1st. In a recent study, no statistically significant changes in cervical volume were found between 1st and 2nd trimester [10]. But that study was conducted in the late 1st trimester (11-14 weeks), whereas our study was conducted earlier in the 1st trimester (9 -13 weeks). In our present study, there was no significant difference in the cervical volume according to the parity, previous delivery mode and previous labor in 1st trimester participants, however the cervical volume was larger in the multipara group when compared to the nullipara group in the 2nd trimester. The cervical volume was larger in the previous vaginal delivery group than in the nullipara and elective groups. On the other hand, there was no significant difference in the labor group when compared to other groups. This might be due to the involvement of various cervical progressions at previous cesarean section in the labor group. This result is similar to the other studies in that the difference of cervical morphology is due to the mechanical stretching of the cervix during labor and not due to hormones [1]. Unlike our results, some studies have announced that there is no difference in the cervical volume using the 3D ultrasound between the nullipara and the multipara groups [18, 19]. But in fact, this studies did not distinguish between gestational weeks and the number of study participants was quite small (n=130 and n=10). Rovas et al. calculated the cervical volume by 3D ultrasound from 17 to 41 of 643 participants and found similar results to our study in that the cervical volume was larger in the multipara than the nullipara groups [11]. Also, Yilmas et al. showed that the second and third trimester cervical volumes were increased in multiparous compared to nuliparas, but there was no significant difference in the 1st trimester [10]. Yet, to date, this study is the first to describe changes in cervical volume using 3D ultrasound in relation to previous delivery mode and labor.

The cervical width was significantly larger in the 2nd trimester than in the 1st. There is no difference according to parity and previous delivery mode in the 1st trimester however, the cervical width is larger in the multipara than the nullipara group in the 2nd trimester. This is also confirmed by other studies using 2D ultrasound [8, 9]. The cervical width is larger in women who underwent labor than in the nullipara and the elective cesarean section groups due to the mechanical change of cervical stretching during labor.

The cervical volume and width have an influence on parity, previous delivery mode and labor in the 2nd trimester. The parity, previous cesarean section and previous labor must be considered when researching cervical volume and width in 2nd trimester patients. Until now, studies on the prediction of preterm labor using the cervical volume have been used to apply uniform standards without considering parity, previous delivery mode and labor [10, 13, 14]. We expect to improve the prediction rate of preterm labor if we make individualized standards based on the results from this study and place greater importance on parity, previous delivery mode and previous labor.

Conflict of Interest

The authors have declared that no conflict of interest exists.

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