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Comparison Between Transvaginal Ultrasonographic Cervical Measurement and Bishop Scores as Predictors of the Onset of Labor and Vaginal Delivery in Nulliparous Women: A Prospective Study

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Abstract

Objectives: In the present study, the transvaginal ultrasonographic cervical measurement and Bishop scores (BSs) as the predictors of the onset of active labor and vaginal delivery were compared in matched patients.

Materials and Methods: This study was done on 150 nulliparous pregnant cases. Transvaginal sonography and digital examinations were performed to determine the cervical length and BS, followed by recording labor induction outcomes and analyzing the obtained values.

Results: According to the obtained results, the cervical length measurement using transvaginal sonography was an independent predictor for labor induction success (AUC = 0.309, $P = 0.046$). The cervical length of 26.75 and 26.25 mm and the BSs of >4 were both found to be the independent predictors of vaginal delivery (AUC = 0.237, $P = 0.002$ and AUC = 0.752, $P = 0.013$), respectively.

Conclusions: In general, the findings demonstrated that the transvaginal ultrasonographic cervical length measurement as an independent predictor factor for labor induction success in nulliparous women was better compared to the BS.

Keywords: Labor, Ultrasonography, Delivery, Cervical length

Introduction

Labor induction can approximately occur in 20% of pregnancies (1). Some factors (e.g., parity, gestational and maternal age, birth weight, body mass index [BMI], and race) are helpful for recognizing the success of labor induction (2-4). In addition, Bishop scores (BSs) were traditionally used to delineate the labor induction. Some studies indicated that BSs ≥5 were successful in labor induction (5, 6). Although previous studies suggested the reliability of BSs in determining the success or failure of the labor induction (3,7-10), these scores are not useful for unfavorable cervices (11).

Ultrasonographic cervical length measurement is another technique for predicting successful labor induction (11-13). Beloosesky et al. reported that the cervical length measurement after 36 weeks has a high predictive accuracy for a successful vaginal delivery after cesarean (14). Further, Park et al demonstrated that the sonographic cervical length could reduce the use of prostaglandin in labor induction by about 50% compared to BSs (15).

Some studies indicated that both methods of BSs and cervical length measurement by transvaginal ultrasonography (TVS) were significantly associated with successful induction (3, 16). In addition, the cervical length of 27 mm and BSs of four were not different in predicting the termination of pregnancy (17). On the other hand, the results expressed that the cervical length measured by TVS is superior to BS in predicting the response to induction (14,18,19).

Previous research studies did not remove pre-eclampsia cases but these cases were omitted in the current study because the use of magnesium sulfate can lead to the failure of labor induction (7,8,16,20). Therefore, the object of this study was to compare the accuracy of TVS cervical measurement with that of BS as a predictor of successful labor induction in singleton nulliparous women.

Materials and Methods

This cross-sectional study was conducted on 150 pregnant women admitted for labor induction at Rouhani Hospital of Babol, Iran from March 2011 to July 2013. All women

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provided written consent. This allocated sample size can detect the effect size =0.4 in pregnancy outcomes between the group under comparison with a 0.5% confidence interval and 80% power. The inclusion criteria were nulliparous women, a live fetus with the cephalic presentation, and singleton term pregnancy, the absence of active labor, an initial cervical examination indicating ≤3 cm dilatation, the absence of pre-eclampsia, and no history of previous uterine incision. The exclusion criteria included vaginal hemorrhage, gross fetal anomaly, and contraindications to vaginal delivery such as placenta previa, placental abruption, and the malpresentation of the fetus. The indications of induction were post-term pregnancy (>41 weeks), intrauterine growth restriction, maternal diabetes, oligohydramnios (amniotic fluid index <5), and decreased fetal movement after 40 weeks of pregnancy. The gestational age was determined based on the date of the last menstrual period and ultrasound measurements in the first trimester. The collected demographic and obstetric data were on maternal age, gestational age, weight, height and the past medical, and obstetrical histories.

The digital-clinical and ultrasonographic assessment of the cervix and BS was evaluated prior to induction.

The TVS cervical measurement was performed by an experienced one who was blinded to the patient's criteria. After bladder emptying and lithotomy position, a probe was gently placed at the anterior fornix of the vagina to create a sagittal view of the complete cervix including the end cervical canal, along with external overall survival (OS) and internal OS. The probe was slowly moved until the image blurred and then the insertion pressure was enhanced to the extent to restore a clear cervical image. The cervical image was enlarged so that it could cover about 75% of the screen. Furthermore, the electronic markers were placed at the farthest points between the internal and external OS, followed by evaluating the cervical length as a direct line. Funneling was defined as a V- or U-shaped indentation of the internal OS of the cervix (15). A Honda electronic HS-4000 (Japan) with a 5-MHz transvaginal probe was used in the current study. Moreover, the BS was assessed for each pregnant woman through a pelvic examination by trained staff. Scoring was as follows:

Dilatation (0 cm: 0, 1-2 cm: 1, 3-4 cm: 2, & ≥5 cm: 3), effacement (0-30%: 0, 40-50%: 1, 60-70%: 2, & ≥80%: 3), the consistency of the cervix (firm: 0, medium: 1, and soft: 2), fetal station (−3: 0, −2: 1, −1: 3, +1, & +2: 3), and the position of cervix (posterior: 0, mid position: 1, and anterior: 2). A BS ≤ 4, identifying an unfavorable cervix was an indication for cervical ripening (21).

A 10 mg dinoprostone (Pharmacia & Upjohn N.V./S.A., Puurs, Belgium) vaginal suppository inserted in the posterior fornix of the vagina for cervical ripening. An intravenous oxytocin infusion began if the patient showed no regular uterine contractions (≥5 in 20 minutes) after 6 hours of dinoprostone insertion (15,22). The dosage at the onset of the process was 2.5 mU/min, which was augmented every half an hour by adding an infusion rate of 205 mU/min. The whole process was continued to the ultimate dose of 40 mU/min until the effective uterine contractions were achieved or the labor represented progression. The process of oxytocin infusion proceeded for about 12 hours. If the active labor did not happen for patients during this 12-hour period, the same protocol would be repeated for the next day to induce labor (15,22). It is worth mentioning that intravenous oxytocin was the only technique for induction in case patients had a BSs of >4. The fetal heart rates were monitored as well. The administration of amniotomy was delayed until the cervix was opened by at least five cm and the vertex was fully occupied (23). A cervical dilatation of 3-5 cm or more can be presented (21). The primary outcome of this study was the onset of active labor. Therefore, the successful induction of labor defined the onset of regular uterine contractions (at an interval of 2-3 minutes) and the cervical dilatation of five cm or greater. Additionally, other outcome variables were considered, including vaginal delivery within 24 or 48 hours of initiating the induction, failure to progress, and the interval from cervical dilatation of five cm to delivery. Failure to progress was confirmed and the cesarean section (CS) was indicated if no cervical dilatation was observed for at least 2 hours during the active phase of labor or if the fetus's head did not descend for at least one hour during the second stage of labor despite all the adequate uterine contractions (7,15,17) after regarding the information on the outcomes of the patients.

The statistical analyses were performed using SPSS18. A univariate analysis was conducted with the Student's *t* test, Fisher exact test, and chi-square test. Eventually, receiver operating characteristic curves were constructed to describe the relationship between the cervical lengths in predicting the failed labor induction. $P<0.05$ was considered statistically significant.

Results

This survey was conducted on 150 consecutively selected nulliparous pregnant women who underwent labor induction. Five women were excluded from the study during labor induction, including three due to pre-eclampsia with increased blood pressure and proteinuria and two others for bleeding and fetal distress. Indications for labor induction were delayed pregnancy (n=89), intrauterine growth restriction (n=3), maternal diabetes (n=4), oligohydramnios (n=22), and decreased fetal movement (n=27). Of the 145 participants, 66 women (45.52%) had a BS >4 when initiating labor induction with oxytocin infusion. Moreover, 79 patients (54.48%) had a BS ≤4 when the 10-mg dinoprostone vaginal suppository was inserted into the posterior fornix. In 22 cases (15.17%), the uterine contractions started after the

insertion of the dinoprostone vaginal suppository. In 57 cases (39.31%), however, the labor induction required oxytocin infusion because the uterine contractions did not begin following the use of a suppository. Table 1 provides the clinical features and delivery results of the patients based on the successful active phase and failure of labor induction. The success and failure of labor induction were significantly related to the BSs before labor induction, sonographically measured cervical length, the presence of funneling, and the use of dinoprostone vaginal suppository. Nevertheless, there were no significant relationships between the successful active phase of labor induction and age, gestational age, BMI, fetal birth weight, and the duration of labor induction. The clinical characteristics and delivery outcomes of pregnant women based on the vaginal delivery or the CS are presented in Table 2. BS before the induction of labor, sonographically measured cervical length, the presence of funneling, BS after the usage of vaginal dinoprostone, and the duration of labor induction had a significant statistical difference in women who underwent CS or vaginal delivery.

BS was inversely associated with the sonographic cervical length and the duration of labor induction ($r = 0.68$, $P < 0.001$ and $r = 0.55$, $P < 0.001$, respectively). In addition, there was a direct relationship between sonographic cervical lengths for labor induction ($r = 0.54$, $P < 0.001$). The best cut-off value of sonographic cervical length for predicting the successful active phase of labor induction and vaginal delivery was 26.75 (AUC = 0.71, sensitivity = 63%, specificity = 73% and $P = 0.002$) and

Table 1. Clinical Characteristics of Pregnant Women Based on Successful Active Phase and Failure of Labor Induction

Characteristics	Induction of Labor		*P* Value
	Successful Active Phase (n = 123)	Failure (n = 22)	
Maternal age (y)	23.4±23.54	24±3.28	0.46[c]
Gestational age (wk)	40.21±0.83	40.41±0.79	0.3[c]
Body mass index	31.82±2.86	33.14±3.03	0.051[c]
Use of dinoprostone	62 (50%)	17 (77.3%)	0.02[b]
Birth weight (kg)	3322.85±398.72	3250.45±246.12	0.41[c]
Bishop score before induction	4.45±1.95	2.91±1.63	0.001[c]
Cervical length by ultrasound (mm)	24.23±5.35	28.41±5.46	0.001[c]
Funneling			
Present	37 (71.2%)	15 (28.8%)	0.001[b]
Absent	86 (92.5%)	7 (7.5%)	
Bishop score after induction	4.5±2.43	3.94±2.41	0.87[c]
Method of delivery			
Vaginal delivery	60 (48.8%)	0 (0%)	0.001 <[b]
Cesarean section	63 (51.2%)	22 (100%)	
Duration of induction			
≤24 hours	24 (92.3%)	2 (7.7%)	0.36[a]
>24 hours	98 (83.1%)	20 (16.9%)	

Note. [a] Chi-square; [b] Fisher exact test; [c] *t* test.

Table 2. The Clinical Characteristics and Delivery Outcomes of Pregnant Women Based on Vaginal Delivery or Cesarean Section

Characteristics	Mode of Delivery		*P* value
	Cesarean Section (n=60)	Vaginal Delivery (n=85)	
Maternal age (y)	23.69±3.29	23.20±3.78	**0.4**[*]
Gestational age (wk)	40.34±0.78	40.1±8.7	0.084[*]
Body mass index	32.29±3.05	31.64±2.7	0.17[*]
Use of dinoprostone	65 (76.5%)	14 (23.3%)	<0.001[*]
Birth weight (kg)	3340.76±351.41	3270.92±416.21	0.27[*]
Bishop score before induction	3.38±1.78	5.4±1.62	<0.001[*]
Cervical length by ultrasound (mm)	27.01±6.02	21.83±2.78	<0.001[*]
Funneling			
Present	49 (94.2%)	3 (5.8%)	<0.001[*]
Absent	36 (38.7%)	57 (61.3%)	
Bishop score after induction	3.58±2.26	6.07±2.05	
≤24 hours	25 (96.2%)	1 (3.8%)	<0.001[§]
>24 hours	60 (50.8%)	58 (49.2%)	

Note. [*] Chi-square; [§]Fisher exact test.

26.25 mm (AUC = 0.80, sensitivity = 54%, specificity = 95% and $P = 0.001$).

The receiver operating characteristic analysis was performed to detect the prognostic effect of BMI, neonatal birth weight, BS and cervical length on successful active phase, as well as CS and CS due to the failure progress (Table 3). Based on the results , only the cervical length was a significant predictor of the successful active phase (the onset of active labor). Further, the estimated AUC = 0.309 (CI 95% = 0.187-0.432) indicated that higher cervical length had a negative effect on successful active phase. As shown in Table 3, the BS is a positive predictor of CS as well (AUC = 0.725, CI 95% = 0.673-0.832). Furthermore, the neonatal birth weight is a positive predictor of CS for a failure to progress (AUC = 0.639, CI 95% = 0.521-0.757). Finally, no such relationship was found between the risk of CS for the progress of labor, cervical length, BS and BMI.

Discussion

The current study indicated that the transvaginal sonographic measurements of cervical length in nulliparous women are independent predictors if these women enter into the active phase of labor and successful induction of labor. Previous research (21) evaluated the efficacy of sonographic cervical length in the prediction of labor induction and concluded that the ultrasound assessment could outperform the BSs. Similar to the results of our study, Yang et al demonstrated that the transvaginal sonographic measurement of cervical length in nulliparous women is an independent predictive factor for the success of labor induction and for entering the active phase of labor (24). Contrarily, Park represented that the cervical length has a poor predictive value for failure to the progress of labor and cesarean delivery (15). It should be noted that the results of the recent studies are based on BS ≤ 4, as well as the sonographic cervical length of (cut-off value) 26.25 for predicting the successful active phase of labor induction and vaginal delivery. Other studies compared the BS and measurement of cervical length with transvaginal sonography and found different results (cut-off values) in this regard. The determination of an optimal cut-off value for the transvaginally measured cervical length for a favorable cervix before labor induction is unclear. This ambiguity can be due to the lack of unifying participants (nulliparous or multiparous, along with inclusion and exclusion criteria), different ways for the induction of labor, and the difference in the outcomes of labor induction (6,15,25,26).

Recent studies demonstrated that the use of multiple logistic regression analysis for the measurement of cervical length with the cut-off value less than 26.25 mm in vaginal sonography could be more impressive than the BS ≤4, which can predict the successful active phase of labor induction in nulliparous women. de Vries reported that the odds ratio for CS was 6.2 (95% CI 2.2-43) for cervical length 20-32 mm and 10 (95% CI 4.8-74) for cervical length >32 mm compared with the lowest quartile of cervical length (27). In addition, Park suggested that the measurement of cervical length with the cut-off value of less than 28 mm in vaginal sonography was more effective than that of BS ≤ 4 for predicting the successful induction of labor in nulliparous women (15). This result is in line with that of Pandis et al which focused on nulliparous and multiparous women (28). Yang et al also found that the cervical length less of than 30 mm made a statistically significant difference in predicting the outcome of labor induction on nulliparous and multiparous women (24). This result is consistent with the findings of the study by Keepanasseril et al conducted on nulliparous women with cervical length of less than 30 mm (29). According to the results of another study (30), the transvaginal sonographic measurement of the cervical

Table 3. The Prognostic Effect of BMI, Neonatal Birth Weight, Bishop Score, and Cervical Length

	AUC	CI 95%	*P*-value	Specificity	Sensitivity
Successful Active Phase					
BMI	0.382	0.252-0.513	0.18	36.36	55.28
Birth weight (kg)	0.571	0.459-0.682	0.32	54.55	59.35
Bishop score before induction	0.652	0.525-0.778	0.94	63.64	66.67
Cervical length by ultrasound (mm)	0.309	0.187-0.432	0.046	31.82	30.08
Cesarean Section					
BMI	0.458	0.364-0.551	0.59	45.88	53.33
Birth weight (kg)	0.431	0.335-0.527	0.4	41.18	46.67
Bishop score before induction	0.752	0.673-0.832	0.013	58.82	91.67
Cervical length by ultrasound (mm)	0.237	0.159-0.314	0.002	42.35	5
Cesarean Section for Failure to Progress					
BMI	0.523	0.399-0.647	0.59	50	57.78
Birth weight (kg)	0.639	0.521-0.757	0.041	60	60
Bishop score before induction	0.417	0.295-0.539	0.22	50	33.33
Cervical length by ultrasound (mm)	0.572	0.450-0.695	0.93	50	64.44

Note. CI: confidence interval; BMI: body mass index.

length compared to the BS before the induction of labor was proved to be a prediction factor for more progress of labor induction. The best cut-off points for predicting the successful induction of labor for cervical length and BS were 24 and 4, respectively. It is worth mentioning that the cervical length in this study was found to be a better predictor than the BS for the success of labor induction (sensitivity 66%, specificity 77%, against sensitivity 77%, and specificity 56%). Likewise, Strobel et al evaluated the nulliparous and multiparous women and concluded that the cervical length and BS could both independently predict labor induction outcomes in nulliparous women 24 hours before the induction. However, the BS was an independent predictor of labor induction in multiparous women at ≤ 48 hours before the procedure (31). A review article investigated the studies on the predictors of labor induction success during 1990-2005.

This review article reported that cervical length measurement and BSs could be of labor induction success. It also emphasized that the cervical length did not have a greater predictive value compared to the BSs (32). The reasons for these differences could be the sample volume, the lack of unifying participants (in terms of parity, age, BMI, and gestational age), the inclusion and exclusion criteria, and various methods for measuring the cervical TVS. In the current research, through receiver operating characteristic analysis, it was demonstrated that neither cervical length nor BS was a predictor of CS for failure to progress, including the result of the study by Park et al (22), while the neonatal birth weight in our study was significantly related to CS due to the failure to progress. However, studies by Gómez-Laencina et al (26) and Meijer-Hoogeveen (33) revealed that the cervical length was the only significant predictor of CS (26,33). The reason for the differences of the results between the study of Park et al and the present study is the use of various methods for measuring cervical length with transvaginal sonography.

Conclusions

The cervical length (measured through transvaginal sonography) was the only independent predictor of successful active phase and vaginal delivery in nulliparous women. Neither the cervical length ≥ 26 nor the BS ≤ 4 could predict the need for CS.

Limitations and Suggestions

The limitation of this study was sample collection since the ultrasound and determination of the BSs were carried out by certain individuals, and the presence of these people was not possible throughout the day. Therefore, many pregnant women were excluded from the study. The present study was conducted on the Caucasian race in Iran. Considering that the race is one of the factors contributing to the progress of labor induction, further studies are objectively recommended with larger sample size in different races using identical materials and methods.

Conflict of Interests

Authors declare that they have no conflict of interests.

Ethical Issues

This study was confirmed by the Ethics Committee of Babol University of Medical Sciences (MUBABOL.REC.1389.5).

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