

The Predictive Value of Trans-Vaginal Ultrasound Measurements Compared with Bishop Score in Determining Successful Induction of Labor

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Abstract

Objectives: Determining the necessity of cesarean section (C/S) due to failure of induction of labor (IOL) is essential to avoid fetus distress. In this study, the performance of the Bishop score and trans-vaginal ultrasound measurements were compared to predict successful IOL, and the most useful cut-off points were estimated.

Methods: Nulliparous women with gestation age of > 37 weeks with a live fetus in cephalic presentation were invited to participate in this study. Bishop score was assessed by digital examination, and trans-vaginal ultrasound was used to measure cervical length. Trans-abdominal ultrasound was utilized to determine the fetal head position.

Results: One hundred women entered the study. Multiple regression analysis revealed that the Bishop score and cervical length had a reliable predictive value in determining successful IOL. The cut-off points for predicting successful induction were 16 mm for cervical length and 5 for the Bishop score, using receiver operating characteristic curves (ROC). Both cervical length and Bishop score were good predictors for vaginal delivery (sensitivity and specificity of 85% and 67%, respectively for cervical length; and 84% and 70%, respectively for Bishop score).

Conclusions: Cervical length is a good predictor of successful IOL. Considering the painful process of digital exam, implementing trans-vaginal ultrasound is preferred.

Keywords: Cesarean Section, Bishop Score, Fetal Head Position, Cervical Length

1. Background

Induction of labor (IOL) is carried out in about 20% of term pregnancies (1). Evidences demonstrate increased rate of necessity for cesarean delivery due to the increased proportion of women with complicated pregnancies, fetal distress and subsequently failure of IOL (2). Successful IOL can be predicted by assessing cervical status. Pre-induction cervical length assessment by trans-vaginal sonography, determining fetal head position and some maternal characteristics, including parity, maternal age and maternal body mass index (BMI), provide useful information to predict the success of IOL (3-5). Although the Bishop score remains the gold standard assessment for cervical status, its subjective nature has raised concerns about its routine use. Moreover, the process of calculating Bishop score is painful. Determining the necessity of cesarean section (C/S) due to failure of IOL is essential to avoid fetus distress

and maternal complications. Therefore, identifying reliable measurements to predict the success of IOL is of prime importance in clinical settings.

Some studies have shown a better performance for trans-vaginal ultrasound measurements compared to Bishop score (6-9). However, other investigations have revealed conflicting results (10, 11). When measuring the Bishop score, sometimes identifying fetal head position is not possible by digital examination. Many studies have demonstrated that trans-vaginal digital examination has not been as accurate as ultrasound measurements in determining the fetal head position (12, 13). Moreover, some studies have recommended the routine use of ultrasound in the first stage of labor (13-15).

2. Objectives

This study aimed to compare the predictive value of trans-vaginal ultrasound measurements, including cervical length and fetal head position, and Bishop score in determining pregnancy outcomes after IOL.

3. Methods

This was an observational follow-up study conducted between June 2013 and June 2014. Study participants were selected among pregnant women admitted for delivery at the delivery center of a teaching hospital, affiliated to Tehran University of Medical Sciences. Prior to the enrollment, written informed consent was obtained from eligible participants, and the aims of the study were explained.

Primigravida women undergoing IOL due to postdate pregnancies, pre-eclampsia, restriction of intra-uterine fetal growth, gestational diabetes mellitus (GDM), gestational cholestasis, oligohydramnios, abnormal fetal well-being and maternal disease were enrolled. Inclusion criteria were as follows: (1) singleton pregnancy; (2) live fetus in cephalic presentation; and (3) gestational age of 37 - 42 weeks. The participants were excluded from the study in case of any contra-indication for induction of labor, including any suspicion of fetal distress at admission, history of previous uterine surgery, contra-indications for vaginal delivery and fetal weight over 4000 gr.

Cervical length measurement was performed using trans-vaginal ultrasound in a dorsal lithotomy position and with an empty urinary bladder. An obstetrician performed all the ultrasound examinations. The trademark of the utilized ultrasound machine was Siemens, equipped with a 7.5 MHz trans-vaginal probe. In a sagittal plane, a clear image from the whole cervix, including internal orifice, the cervical canal and external orifice, was used to measure cervical length. Three measurements were made for each participant, of which the shortest was the cervical length. Fetus head position (anterior, transverse and posterior) and fetal weight were determined by trans-abdominal sonography. Ultrasonographic assessment of the fetal head position was performed utilizing midline intracranial structures (cavum septi pellucidi, falx cerebri, thalami and cerebellar hemispheres), and anterior or posterior cranial structures (orbits, nasal bridge and cervical spine). Head position was classified as occiput anterior (OA), posterior (OP), and occiput transverse (OT). In cases of OA, the cervical spine and cerebellum were, respectively, on the midline of the maternal abdomen between the left or right anterosuperior iliac spine and the pubis. In case of OP, fetal orbits are symmetrically located on each side of the maternal pubic bone. In cases of (OT), the cervical spine

is located at the level of the right or left anterosuperior iliac spine (12, 13).

After performing the ultrasound and immediately before IOL, the Bishop score was assessed by another obstetrician who was blinded to the ultrasound measurements. Scoring was as follows: Position of cervix (posterior: 0, intermediate: 1, anterior: 2), consistency of the cervix (firm: 0, intermediate: 1, soft: 2), effacement (0 - 30%: 0, 31 - 50%: 1, 51 - 80%: 2, > 80%: 3), dilation (0 cm: 0, 1 - 2 cm: 1, 3 - 4 cm: 2, > 5 cm: 3), fetal station (-3: 0, -2: 1, -1 and 0: 2, +1 and +2: 3). A score < 5 suggests that labor is unlikely to start without induction. A score > 9 indicates that labor will most likely commence spontaneously (16).

Labor was induced with low-dose oxytocin. The infusion of oxytocin was started at 1 mU/min and increased by 1 - 2 mU/min every 20 minutes until adequate uterine contraction was obtained (17). Indications for induction of labor in the participants were postdate pregnancies, cholestasis, pre-eclampsia, restriction of intra-uterine fetal growth, diabetes mellitus, abnormal fetal well-being, oligohydramnios, and maternal medical disease.

Amniotomy was performed if the cervix was favorable (Bishop score \geq 6). Successful IOL was defined as vaginal delivery regardless of the required time for its occurrence. Similar dosage and method to induce labor were applied for all women. For those patients with Bishop score < 5, 25 mg Misoprostol was administered before IOL.

Fetal heart rate was intermittently monitored, using external cardiotocography. To evaluate the progress of cervical dilation and effacement, digital cervical examination was scheduled every six hours. After the participant entered into the active phase of labor, the examination intervals were shortened to every four hours, and external cardiotocography was performed continuously (18-20).

In this study, delivery by Cesarean section was indicated if failure to progress following induction of labor was obtained, or in case of suspected pelvic-fetal disproportion, or suspected fetal distress. A workshop convened by the United States National Institute of Child Health and Human Development, Society of Maternal-Fetal Medicine, and American College of Obstetricians and Gynecologists proposed that failed induction is defined as a failure to generate regular contractions approximately every three minutes and cervical change after at least 24 hours of oxytocin administration (19).

Continuous variables were expressed as mean \pm standard deviation (SD). Categorical variables were described as count and percentage. To measure normality of the distribution, Kolmogorov-Smirnov test was employed and was further confirmed visually, using normal probability plots. Comparison of categorical variables between groups (normal vaginal delivery (NVD) and C/S) was performed us-

ing Pearson Chi-square and Fisher's exact tests. One-way analysis of variance (ANOVA) was conducted to compare means between groups. The predictive value of ultrasound measurements and Bishop scores for a successful vaginal delivery was evaluated, using receiver-operating characteristics (ROC) curves. All statistical analyses were performed, using SPSS software, Version 16 (SPSS Inc., Chicago, IL, USA). The P values less than 0.05 was considered statistically significant.

4. Results

One hundred nulliparous women were enrolled in the study. Cervical length and Bishop score were determined for all patients in the study group. Table 1 illustrates the baseline and demographic characteristics of the participants. In this study, all participants had a full term pregnancy between 37 - 42 weeks, and gestational age was not statistically different between the two groups.

Mean Bishop score at the time of examination was 4.3 (SD 1.6; range 1 - 9). Mean cervical length, measured by trans-vaginal ultrasonography, was 25.2 mm (SD 1.6; range 11 - 45) at the time of the examination.

Eighty-nine women experienced the active phase of labor after IOL, but only 57 participants had NVD, and 43% needed Cesarean section (C/S). Eleven participants did not enter the active phase, and despite the adequate contraction of the uterus, no change was detected in the cervical dilatation progress.

The indications of C/S were failure to progress or fetal distress. Maternal characteristics of the mode of delivery are shown in Table 2. No significant differences were observed between the two groups in maternal age, gestational age or neonatal weight (C/S and NVD). Means of BMI before pregnancy were 23.52 ± 3.56 and 24.91 ± 3.57 kg/m² in women who had NVD and C/S, respectively (P: 0.021). Fetus gender was male in 46% of the deliveries. Bishop score was < 5 in 77% of term pregnancies (Table 1). There were higher cervical length and lower Bishop score in C/S group compared to the vaginal delivery group. Multivariate regression analysis of the likelihood of vaginal delivery revealed a statistically significant association with Bishop score (OR: 1.3, P = 0.03) and cervical length (OR: 0.41, P = 0.016). This analysis revealed that significant independent prediction of normal vaginal delivery could be provided by Bishop score and cervical length. Sensitivity and specificity of Bishop score were 0.85 and 0.67, respectively. Sensitivity and specificity of cervical length were 0.84 and 0.70, respectively (Table 3). The cut-off points of cervical length and Bishop score were 16 and 5, respectively (Table 4). Among women who had successful vaginal delivery, fetus occiput position was anterior in 36.8%, transverse in

Table 1. Demographic and Baseline Characteristics of the Participants

Item	Value (n:100)
Maternal age (year)	
Mean (SD)	25.1 (4.4)
Range	17 - 40
Gestational age at examination (week)	
Mean (SD)	39.1 (3)
Median	39
Range	37 - 42
Maternal BMI at conception	
Mean (SD)	24.1 (3.5)
Range	18 - 34
Indications for induction, n (%)	
Postdate pregnancies	17 (17)
Cholestasis	5 (5)
Pre-eclampsia	13 (13)
IUGR	15 (15)
Abnormal fetal wellbeing	17 (17)
Oligohydramnios	16 (16)
Diabetes Mellitus	14 (14)
Maternal Disease	3 (3)
Bishop score	
Mean (SD)	4.3 (1.6)
Range	1 - 9
Cervical length (mm)	
Mean (SD)	25.2 (7.1)
Range	11 - 45

Abbreviations: BMI, Body Mass Index; IUGR, Intra-Uterine Growth Retardation; ROM, Rupture of Membranes.

47.4% and posterior in 15.8%. Similarly, fetus occiput position was anterior in 28%, transverse in 46.5%, and posterior in 25.5% among candidates of C/S.

5. Discussion

The findings of this study revealed that ultrasound measurement of cervical length is comparable to Bishop score in predicting the outcome of labor induction. This study demonstrated that among pregnancies over 37 weeks of gestation, a cervical length of lower than 16 mm, as measured by trans-vaginal sonography, could predict that NVD is expected with a sensitivity of 85% and specificity of 67%. The same was found for the Bishop score of

Table 2. Maternal Characteristics of the Mode of Delivery

	NVD	C/S	P Value
Maternal age (year) (Mean ± SD)	25.6 ± 4	24.47 ± 3.9	0.19
Gestational age (week) (Mean ± SD)	39.4 ± 2	39.2 ± 2	0.17
BMI (Mean ± SD)	23.4 ± 3.6	25.5 ± 3.6	0.021
Neonatal weight (g) (Mean ± SD)	3364.9 ± 283	3293.3 ± 507	0.470

Abbreviations: BMI, Body Mass Index; C/S, Cesarean Section; NVD, Normal Vaginal Delivery; SD, Standard Deviation.

Table 3. Comparison of the Measured Cervical Length and Bishop Score among Women with Normal Vaginal Delivery and Candidates of Cesarean Section

	NVD	C/S	P Value	Adj (CI, 5%)
Cervical length	23.97 ± 6.55	26 ± 7	0.041	0.004 (-0.04 - 0.03)
Bishop score	4.63 ± 1.55	3.93 ± 1.6	0.030	-0.03 (-0.13 - 0.06)

Abbreviations: CI: Confidence Interval, C/S: Cesarean Section, NVD: Normal Vaginal Delivery

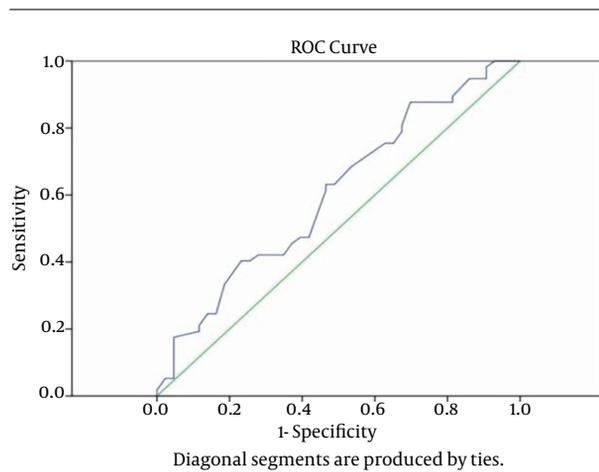


Figure 1. Receiver Operating Characteristic Curves (ROC) of Cervical Length in Predicting Successful Vaginal Delivery after Induction of Labor

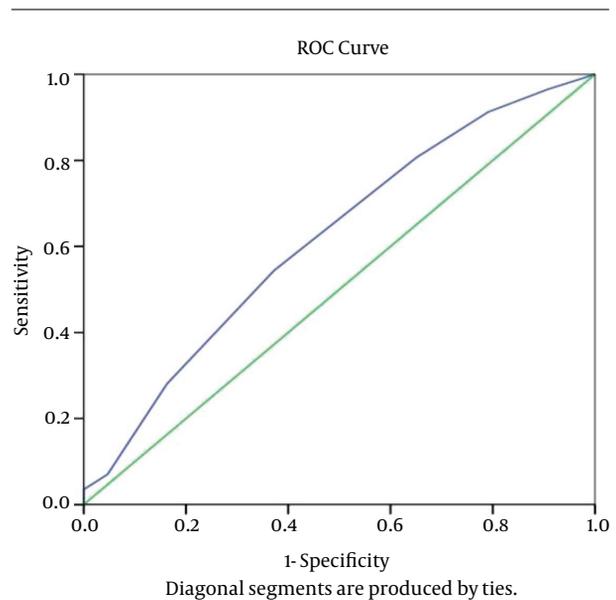


Figure 2. The Receiver Operating Curve (ROC) of Bishop Score in Predicting Successful Vaginal Delivery after Induction of Labor

higher than 5 with a sensitivity of 80% and specificity of 70%.

Mode of delivery is influenced by various factors such as gestational age, fetal presentation, fetal weight, parity, maternal BMI and cervical status. In this study, all women were nulligravid and the weight of all fetuses was below 4 kg. Fetus gender and weight did not differ between the two groups. These outcomes revealed that BMI could be considered as a factor affecting the progress of delivery, whereas age, fetus gender and weight were not determinants of suitability of IOL. It was further found that BMI was significantly higher in the Cesarean section group. Different induction agents have an impact on the duration of labor and mode of delivery. Cervical ripening is a dynamic

process in pregnancy, and change in cervical length starts in the late third trimester before induction of labor. In this study, all patients had a full term pregnancy between 37-42 weeks, and there were no significant differences between the two groups in terms of gestational age.

No significant differences were found between Bishop score and cervical length in predicting vaginal delivery. On the other hand, significant differences were observed between cervical length and Bishop score between NVD group and candidates of Cesarean section. Therefore,

Table 4. Comparison of Test Sensitivity and Specificity between Cervical Length Measured by Trans-Vaginal Ultrasound and Bishop Score

	AUC	Sensitivity	Specificity	Cut off Point	P Value
Cervical length	0.604	85	67	16	0.050
Bishop score	0.618	84	70	5.5	0.044

Abbreviations: AUC, Area under Curve.

Bishop score and cervical length, measured by trans-vaginal sonography, provide useful information on predicting mode of delivery after induction of labor.

Conflicting results have been reported when comparing Bishop score and ultrasound measurements, such as assessment of cervical length (21-26). Strobel et al. (27) and Rozenberg et al. (10) illustrated that Bishop score and cervical length assessment (measured by ultrasound) are similarly accurate in predicting spontaneous labor. Strobel et al. (27) found that the combined use of Bishop score and cervical length is a better predictor than utilization of each method alone.

Keenanasseril et al. (28) showed that trans-vaginal assessment of the cervix before IOL can predict mode of delivery in nulliparous women better than Bishop score. They reported a cut-off point of 30 mm for the cervical length with sensitivity of 85% and specificity of 91% for predicting vaginal delivery. Young et al. (26) found that a cervical length less than 30 mm have a sensitivity of 75% and specificity of 83% in predicting successful induction of labor. Moreover, Tan et al. (29) demonstrated that ultrasound measurement of cervical length have a similar value to Bishop score in predicting the necessity of cesarean section. Our results showed that the cut-off point of 16 mm for cervical length has a sensitivity of 85% and specificity of 67% in predicting successful IOL. Pandis et al. (30) reported that ultrasound measurement of cervical length had 20% higher sensitivity than Bishop score.

Ultrasound examination is a safe, quick and non-invasive method that provides valuable objective measurements to monitor the progress of a labor. Our study approved the superior (no significant difference) predictive value of cervical length measured by trans-vaginal ultrasound compared to Bishop score, which has also been demonstrated in previous studies (30-33). Furthermore, it seems that extreme measures in both methods (very low Bishop score vs. unsuitable cervical length) can predict the necessity of C/S with a similar value. To our knowledge, this was the first study on a homogenous population that compared the predictive value of Bishop score and trans-vaginal ultrasound measurements in determining suitability of IOL.

In this study, range of fetus weight was similar among

women with NVD and candidates of C/S, so the role of fetus weight in determining failure of IOL could not be evaluated. No beneficial effect of anterior occiput position was detected in predicting successful IOL. It seems that proper prediction of successful vaginal delivery requires combined consideration of maternal factors and ultrasound measurements for each individual (34, 35).

In line with Eggebø et al. (36), the role of maternal age in predicting successful IOL was insignificant in our investigation, which contradicts the findings of Rane et al. study (37). One reason for this difference was our participants, as they were only primigravid women, who had relatively similar ages and were younger than multiparous women.

The rate of delivery by C/S was 43% in our department, which is noticeably higher than Cesarean rate in Norway (13%) and is similar to Mexico (43.9%), Italy (39.8%) and South Korea (35.3%) (38). There are many factors that affect this increasing Cesarean trend, including socio-economic class (39), protocol of the related hospital (40), and improved technology (41). It seems that the characteristics of population in each nation affect the rate of C/S. Therefore, more investigations are required to determine the Iranian population features to clarify the reasons behind this high rate of C/S.

Fetus gender and weight did not differ between the two groups. These outcomes revealed that BMI can be considered as a factor affecting the progress of delivery, while age, fetus gender, and weight were not determinants of suitability of IOL.

Footnotes

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