Original Article

Transvaginal Sonographic Cervical Length versus Bishop Score in Labor Induction to Predict the Risk of Cesarean Delivery: A Comparison Study†

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Objective: To compare reliability of cervical length [CL] versus Bishop score [BS] in prediction of the risk of cesarean delivery.

Materials and Methods: We conducted a prospective study in 128 pregnant women admitted to Bhumibol Adulyadej Hospital between December 2014 and July 2016 and received the treatment for induction of labor. All patients were measured for CL using transvaginal ultrasonography [TVUS] followed by pelvic examination for BS assessment. Primary outcome was reliability of CL and BS to predict the risk of cesarean delivery. Secondary outcome was pain score derived from both techniques.

Results: Sixty patients underwent cesarean section. Of these, there were 54.8% of patients with CL greater than 2 cm, and 63% of patients with BS of 5 or less. Regarding to prediction of cesarean delivery, CL had a higher sensitivity (85%, 95% CI 79 to 94) than BS (76.7%, 95% CI 66 to 88). We also found that TVUS for CL measurement had a lower pain score than BS assessment using pelvic examination (1.37 vs. 4.20, $p = 0.0001$).

Conclusion: CL derived from TVUS had a higher sensitivity to predict the risk of cesarean delivery and had a lower pain score compared to BS assessment using pelvic examination.

Keywords: Induction of labor, Cervical length, Bishop score

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The goal of induction of labor is to achieve vaginal delivery by stimulating uterine contractions before spontaneous onset of labor. Induction of labor is indicated when the benefits to either mother or fetus outweigh those of pregnancy continuation. The indication for induction is attributed to a number of factors including health problems and obstetrics complications in pregnancy. The labor induction rate was approximately 22%[1], instrumental births was 15%, and emergency cesarean delivery was 22%[2].

The Bishop score [BS] is the only one standard method to predict the outcome of labor induction. BS pelvic scoring system comprises of cervical dilation, cervical effacement, cervical consistency, cervical position, and fetal station, with a maximum score of 13[3]. A score of more than 9 usually associates with a very high success rate of labor induction, while a score of 5 or less identifies an unfavorable cervix[4]. However, this assessment is somewhat subjective and hence might be unreliable[5-7]. Transvaginal ultrasonography [TVUS] measurement of cervical length [CL] has been evaluated as BS, and some studies demonstrated a more sensitive prediction of cesarean delivery than BS in women undergoing induction of labor[8]; however, this finding has not been reported consistently[9]. In addition, the pelvic examination for the BS assessment is more painful than TVUS.

The aim of the present study was to compare reliability of the TVUS CL and the BS in predicting the risk of cesarean delivery as well as pain tolerability.

Material and Method

Patients

We performed a prospective cohort study, which was conducted in pregnant women with gestational ages between 37 and 42 weeks that visited our delivery suit, Department of Obstetrics and Gynecology, Bhumibol Adulyadej Hospital, for labor induction, between December 2014 and July 2016. The inclusion criteria were 1) singleton fetus, 2) intact amniotic

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membranes, and 3) cephalic presentation. Pregnant women with intrauterine fetal death, non-reassuring fetal status, or known gross fetal anomaly were excluded from the present study. All women gave their written informed consent and the study was approved by the Ethics Committee, Bhumibol Adulyadej Hospital. Upon arrival at the labor and delivery unit, transvaginal 2D ultrasound for the measurement of CL and pelvic examination to determine the BS were performed by the same examiner. Following the examinations, each woman was asked to indicate on a 10-point visual analog scale [VAS] her perception of pain during the procedures, with a score of 0 representing no pain and a score of 10 denoting unbearable pain.

Cervical length

TVUS assessment of CL was performed, after patient's bladder was emptied, by one resident who was trained in CL measurements performing the TVUS, using a Sonoacer R3 (Samsung Medison Co. Ltd., Seoul, Korea) machine equipped with a 6 MHz transvaginal probe. Sagittal image of CL has been described previously[10]. The CL was measured from the internal os to the external os in straight line. Three cervical images were acquired, and the shortest distance was taken for analysis. Regarding the previous recommendation by Tan et al[4], we defined that the patient had a short cervix if the CL was 20 mm or less.

Induction of labor

Induction of labor was carried out according to the standard labor induction protocol of Bhumibol Adulyadej Hospital. External electronic monitoring was performed to assess fetal wellbeing and uterine contraction. Oxytocin was administered intravenous as a dilute solution using a constant-infusion pump. The initial dose was set at 2 mU/minute and increased by one-half of the previous infusion rate every 30 minutes up to a maximum dose of 20 mU/minute until regular painful uterine contractions ensued or labor progressed. The oxytocin infusion was continued for at least 11 hours. In patient who did not go into active labor during this period, the induction was re-administered the next day.

Statistical analysis

Primary outcome was the odds of cesarean delivery. The secondary outcome was pain scores using a VAS scale. The student's t-test was used to compare continuous normally distributed variables. Categorical data were assessed using Chi-square test. The continuous data was expressed as a mean ± standard deviation [SD] with 95% confidence interval [CI] where applicable. For statistical analysis, the GraphPad and SPSS version 18.0 were used. The significant level was set at 0.05.

Results

One hundred twenty eight women hospitalized for induction of labor were enrolled in the present study. There were 68 nulliparous and 60 multiparous women. Demographic data of all participants are shown in Table 1. Indications for induction of labor included prolonged pregnancy beyond 41 weeks of gestation (n = 50), oligohydramnios (n = 25), pregnancy induced hypertension (n = 14), diabetic pregnancies (n = 12), suspected fetal growth restriction (n = 10), and other medical features (n = 17). TVUS was better tolerated than BS assessment (VAS 1.4±1.6 versus 4.2±1.8; mean difference 2.8±0.2, p<0.0001). The overall cesarean delivery was 46.9%.

Upon arrival at the delivery room, CL of 20 mm or less were found in 25 cases, and CL greater than 20 mm were found in 93 cases. Cesarean delivery was performed in nine women with short cervix and

Table 1. Baseline characteristics of women who were admitted for induction of labor

Characteristics	n (%)
Maternal age (year)	
<20	20 (15.6)
20 to 34	87 (68.0)
>34	21 (16.4)
Parity	
Nulliparous	68 (53.1)
Multiparous	60 (46.9)
Body mass index (kg/m^2)	
<30	85 (66.4)
≥30	43 (33.6)
Indication for cesarean delivery	
Failed induction	35 (27.3)
Failure to progress	14 (10.9)
Cephalopelvic disproportion	8 (6.3)
Unfavorable cervix	3 (2.3)
Height (cm), mean ± SD	158.32±6.30
Gestational age (week), mean ± SD	39.30±1.40
Birth weight (gm), mean ± SD	3,155.70±438.90
Pain score on VAS, mean ± SD	
Sonography	1.37±1.60
Bishop score	4.20±1.80
Route of delivery	
Cesarean delivery	60 (46.9)
Vaginal delivery	68 (53.1)

BMI = body mass index; VAS = visual analog scale

performed in 51 women with a long cervix (25.7 versus 54.8, odds ratio of 3.5). Seventy-three cases had a BS of 5 or less and 55 cases had a BS greater than 5. Cesarean delivery was performed in 14 women with short cervix and in 46 women with long cervix (25.5 vs. 63.0, odds ratio of 4.9) (Table 2).

The cut-off point of CL to predict cesarean delivery was greater than 20 mm[4] corresponded to a sensitivity of 85%, a specificity of 38%, a positive predictive value of 55%, a negative predictive value of 74%, and accuracy of 60%. For BS, a score of 5 or less[4,11] corresponded to a sensitivity of 77%, a specificity of 60%, a positive predictive value of 63%, a negative predictive value of 75%, and accuracy of 67%. Comparisons between TVUS for CL and BS in predicting cesarean delivery are shown in Table 3.

Of those 128 women, 60 women were performed cesarean delivery (46.9%) and 68 women successfully delivered vaginally (53.1%). These two groups of patients were similar in regard to maternal age, body mass index, height, VAS pain score, birth weight, and Apgar score at 1 minute and 5 minutes. Compared to patients with successful vaginal delivery, women who were performed cesarean delivery had significant less gestational age at delivery, higher proportion of nulliparous, greater CL, and higher proportion of patients with indications for induction (Table 4).

Table 2. Comparison of cervical length (derived from transvaginal ultrasonography) vs. Bishop score based on mode of delivery

	Cesarean delivery n (%)	Normal delivery n (%)	Odds ratio
Cervical length (cm)			3.5 (1.5 to 8.3)
>2	51 (54.8)	42 (45.2)	
≤2	9 (25.7)	26 (74.3)	
Bishop score			4.9 (2.3 to 10.8)
≤5	46 (63.0)	27 (37.0)	
>5	14 (25.5)	41 (74.5)	

Table 3. Comparison of cervical length derived from transvaginal ultrasonography vs. Bishop score for prediction risk of overall cesarean delivery following induction of labor

Parameter	Prediction of overall cesarean delivery			
	Cervical length >2 cm		Bishop score ≤5	
	n (%)	95% CI	n (%)	95%CI
Sensitivity	51/60 (85)	79 to 94	46/60 (77)	66 to 88
Specificity	26/68 (38)	26 to 50	41/68 (60)	48 to 80
Positive predictive value	51/93 (55)	45 to 65	46/73 (63)	52 to 74
Negative predictive value	26/35 (74)	59 to 89	41/55 (75)	52 to 74
Accuracy	77/128 (60)		87/128 (68)	
False positive	42/68 (62)		27/68 (40)	
False negative	9/60 (15)		14/60 (23)	
Prevalence	60/128 (47)	38 to 56	60/128 (47)	38 to 56

Discussion

The BS is the standard method for evaluating cervical conditions before induction of labor. However, it is widely accepted that this score is of limited value, especially in the case of an unfavorable score. TVUS measurement of CL is another method that can be achieved easily with less discomfort to evaluate outcome of induction. However, the physicians who undertake this measurement should receive appropriate training because the technique at term gestational age is more difficult compared to mid-trimester cervical assessment, especially when the head is engaged, and the alignment of the cervix is distorted.

In the present study, TVUS for CL was successfully achieved in all cases. We demonstrated that in singleton pregnancies undergoing induction of labor with oxytocin infusion at gestational age of 37 to 42 weeks where the main indication was prolonged pregnancy, the cesarean delivery rate was 46.9%. Different from the present study, Tan et al[4] showed a cesarean delivery rate of 22.1%, Pandis et al[12] rate was 20%, and Park et al[13] rate was 31.2%. The possible explanation was because of using different method of induction of labor and cut-off values can yield different findings.

Our results showed the TVUS measured CL is better than the BS in predicting the outcome of induction. TVUS for CL threshold of greater than 20 mm has a sensitivity of 85%, a specificity of 38%, and a negative predictive value of 74%. For BS of 5 or less[4,11] has a sensitivity of 77%, a specificity of 60%, and a negative predictive value of 75%. These findings aligned to previous study by Tan et al[4], which showed similar result in a sensitivity, specificity, and negative predictive value.

We also found that, compared to vaginal delivery, cesarean delivery had significantly higher proportion of primiparous, patients with indication for induction and CL. Compared to other studies, Tan et al[4] reported an increased rate of cesarean delivery in primiparous and CL, while Pandis et al[12] and Rane et al[14] reported that success rate of vaginal delivery depend on contributions of CL, parity, and the BS. In our study, indication for induction was different from those studies because this group had higher primiparous (than vaginal delivery), especially in women with diabetes and hypertension. Vaginal delivery had gestational age

Table 4. Characteristics and outcomes of 128 women stratified according to mode of delivery

	Cesarean delivery (n = 60), n (%)	Vaginal delivery (n = 68), n (%)	*p*-value
Maternal age (year)			0.95
<20	10 (16.7)	10 (14.7)	
20 to 34	40 (66.6)	47 (69.1)	
>34	10 (16.7)	11 (16.2)	
Parity			0.001
Nulliparous	45 (75.0)	23 (33.8)	
Multiparous	15 (25.0)	45 (66.2)	
BMI (kg/m^2)			
<30	35 (58.3)	50 (73.5)	0.69
≥30	25 (41.7)	18 (26.5)	
Indications for induction of labor			0.003
Oligohydramnios	8 (13.3)	17 (25.0)	
Prolonged pregnancy	19 (31.7)	31 (45.6)	
Hypertension	11 (18.3)	3 (4.4)	
Diabetes mellitus	9 (15.0)	3 (4.4)	
Growth restriction	2 (3.3)	8 (11.8)	
Other	11 (18.3)	6 (8.8)	
Apgar score			0.49
Apgar score >7 at 1 minute	58 (96.7)	67 (98.5)	
Apgar score >7 at 5 minute	60 (100)	68 (100)	
Height, cm, mean (95%CI)	158.5 (156.8 to 160.1)	158.2 (156.7 to 159.7)	0.81
Gestational age (weeks), mean (95% CI)	39.0 (38.6 to 39.3)	39.6 (39.2 to 39.9)	0.02
Cervical length (cm), mean (95% CI)	2.65 (2.48 to 2.82)	2.36 (2.16 to 2.56)	0.03
Pain score on VAS, mean (95% CI)			
Sonography	1.4 (1.0 to 1.8)	1.38 (1.0 to 1.8)	0.91
Bishop score	4.5 (4.1 to 5.0)	3.9 (3.5 to 4.4)	0.06
Birth weight, gm, mean (95% CI)	3,181.2 (3053.7 to 3308.6)	3,133.3 (3039.6 to 3227.0)	0.54

BMI = body mass index; VAS = visual analog scale

at delivery greater than four days and statistical significance was observed.

Limitations of the present study included small sample size, which did not allow stratification of primiparous from multiparous in investigating the differences in the accuracy of the CL cutoff point. Another limitation was the difference of induction protocol that might influence the outcome of induction, and the results could not apply to the unit that used protocol for cervical ripening, such as prostaglandin or mechanical devices. However, the present study had several strengths. First, the data were obtained from a real-life setting with one resident trained in CL measurements that performed the TVUS. Second, the obstetricians making management decisions were blinded to the CL measurement, thereby decreasing bias in the interventions. Based on the results of the present study, we concluded that the CL derived from TVUS had a higher sensitivity to predict the risk of cesarean delivery and had a lower pain score compared to BS assessment using pelvic examination.

What is already known on this topic?

The BS is the standard method for evaluating cervical conditions before induction of labor. However, it is widely accepted that this score is of limited value, especially in the case of an unfavorable score. The CL derived from TVUS is one method that has a higher sensitivity to predict the risk of cesarean delivery and has a lower pain score compared to BS assessment using pelvic examination.

What this study adds?

The CL derived from TVUS plays an important role in predicting the risk of cesarean delivery and has a lower pain score compared to BS assessment using pelvic examination.

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Potential conflicts of interest

The authors declare no conflict of interest.

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