

Cervical length and posterior-cervical angle in prediction of successful induction of labor

Sabry Sayed Mohamed Hassan, Ahmed Elsayed Ahmed Omar*, Ahmed Mohamed Essam, El-Din Mahmoud Mansour
Department of Obstetrics and Gynaecology, Faculty of Medicine, Ain Shams University, Cairo, Egypt

SUMMARY

AUTHORS' CONTRIBUTION: (A) Study Design · (B) Data Collection · (C) Statistical Analysis · (D) Data Interpretation · (E) Manuscript Preparation · (F) Literature Search · (G) Funds Collection

Objective: "Bishop score has been used to predict successful labor induction; however, ultrasound detecting cervical parameters (cervical length and posterior-cervical angle) may be superior to Bishop score. The present study was an effort to determine which is better for predicting successful labor induction.

Methods: A prospective observational study has been performed on 100 pregnant women with 37-41 weeks' gestational age who had been acclaimed to undergo labor induction. Cervical length, posterior cervical angle, and Bishop Score were also assessed and their relations to successful induction of labor were evaluated.

Results: The posterior cervical angle sensitivity, specificity, and accuracy for predicting successful labor induction were 92%, 89%, and 89%, respectively, which were superior to those of Bishop Score as well as cervical length. Moreover, both posterior cervical angle and cervical length combined use for predicting the successful labor induction show sensitivity 94%, specificity 91% and accuracy 91%. Using ROC curve, our results showed that the best area under curve (AUC) is for combined ultra-sonographic parameters (0.940, 95% CI 0.823 – 0.901).

Conclusion: For predicting the labor induction outcome, the combined use of both cervical length and posterior cervical angle was superior to the Bishop score.

Keywords: Induction of labor; Cervical length; Posterior cervical angle; Bishop score

Address for correspondence:

Dr. Ahmed Elsayed Ahmed Omar
Department of Obstetrics and Gynecology, Faculty of Medicine,
Ain Shams University, Cairo, Egypt
Tel: + 201019391381
E-mail: Gynecologistomar91@gmail.com

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INTRODUCTION

Induction of labor (IOL) is a popular obstetrical procedure, accounting for about 20–30% of all deliveries [1]. In women with an unripe cervix, IOL helps to avoid possible complications for the mother and the fetus [2].

Although following IOL, vaginal delivery (VD) is expected, complications may hinder the delivery, and the labor may fail to progress, which is defined as an unsuccessful IOL; accordingly, cesarean section (CS) is the alternative option. Low Bishop score (<6), maternal obesity, nulliparity, and gestation age <41 weeks; are all considered as possible causes of unsuccessful IOL [3].

In clinical practice, the Bishop score [4] is the most commonly used way to evaluate the cervical condition [5]. However, some investigators concluded that Bishop score is a flawed method for predicting the success of IOL due to the imprecise nature of cervical assessment. Bishop score faces difficulties in evaluating the internal OS changes, especially while the external OS is closed. In addition, this is considered a subjective measurement influenced by the clinical experience of the physician [6].

Transvaginal ultrasound (TVUS) parameters have been shown superiority over the conventional Bishop score in evaluating the cervix before IOL. This superiority is explained by the reproducibility of TVUS data and learning feasibility [7]. Cervical length (CL) and posterior-cervical angle (PCA) are two ultrasound parameters that have been identified to evaluate the clinical functionality of the cervix that assess the quality of cervical integrity [8].

This study aimed to assess the reliability of measuring both PCA and CL using TVUS compared with Bishop score to predict the success of IOL.

MATERIALS AND METHODS

Study design: A prospective observational study (Accuracy of diagnostic test study) was carried out on 100 pregnant women admitted for IOL at Ain Shams University Maternity Hospital during the period from October 2019 to October 2020.

Study population: All women included in the study were primigravida, with one live fetus in cephalic presentation. The candidates were not in active labor which is defined as (cervical dilatation >4-cm or cervical effacement >80%) [9]. However, all pregnant women with confirmed fetal anomalies, amniotic fluid disorders, Bishop score >8, antepartum hemorrhage, cephalopelvic

disproportion, previous cervical operation, previous cesarean delivery and myomectomy (previous uterine scar), and those who are morbidly obese (Body Mass Index (BMI) over 40 calculated as weight in kilograms divided by square of height in meters), fetal macrosomia (fetal weight 4 kg or more measured by ultrasonography), fetal distress, or uterine anomalies were excluded from the study.

Ethical approval: The study was presented for approval from the Ethical Committee of the Department of Obstetrics and Gynecology, Faculty of Medicine, Ain Shams University. Informed consent was received from all participants after counseling them on the nature of the study.

METHODS

All women were subjected to full history taking, physical examination, ultrasonography examination by two ultrasound experts;

- a) Abdominal ultrasound was done by Samsung (Seoul, South Korea) ultrasound system by frequency 7 MHZ to determine fetal viability, weight, number, amniotic fluid, and placental site.
- b) Transvaginal ultrasound (TVUS) was performed with an empty bladder in the lithotomy position with a frequency 4 -9 MHZ by Samsung (Seoul, South Korea) ultrasonography machine. Gently, the vaginal probe was introduced into the vagina till the back of the fornix was reached to see the whole cervical length. A sagittal cervix plane has been obtained, ensuring proper visualization of the full length of the cervical canal. The calipers were put between both the inner and outer cervical openings for the CL measurement. We measured the angle between the line used in measuring the CL and the back of the uterine wall for the PCA measurement [10]. Finally, to calculate the Bishop score, a digital examination was done [11]. Measurements of both CL and PCA were kept blinded from the investigator who performed the Bishop scoring.

Induction of Labor: The protocol for IOL followed the local university hospital protocol. We gave cervical ripening agents in the form of a vaginal tablet containing 25 µg misoprostol (Vagiprost; Adwia, Cairo, Egypt) to those with a firm or closed cervix to be repeated at least after 4 hours up to 5 doses. In comparison, women with a flexible cervix and others improved by misoprostol were given an intravenous oxytocin infusion (Syntocinon; Novartis, Basel, Switzerland). The initial dosage was 5 units (in 500 ml Ringer solution), an average of 12 drops per minute. Each half an hour, we doubled the dosage till we reach effective constrictions, the maximum dose up to 96 drops per minute.

We compared the measured PCA and CL with bishop score for evaluation of successful IOL that was defined as the time interval for induction to active labor (according to ACOG [9] where cervical dilatation >4-cm or cervical

effacement >80%). In comparison, unsuccessful IOL was defined as cesarean delivery because of failed progress of labor. Women who had a cesarean delivery for reasons other than failed IOL, such as prepartum hemorrhage, fetal distress, and cephalopelvic disproportion, were excluded from the data analysis.

Statistical analysis of the data: Data were fed to the computer using IBM SPSS software package version 20.0. Qualitative data were described using numbers and percent [12]. Detailed information is explained in the supplementary materials (addendum).

RESULTS

The present study included 100 pregnant women aged 18-39 years with gestational age from 37-41 weeks. Demographic, clinical, and ultrasonography characteristics of the study group are illustrated in Tab. 1.

Regarding induction of Labor, unsuccessful IOL was recorded in 17 women (17%), including eight women (8%) with fetal distress and nine women (9%) with failed IOL. Whereas successful IOL was reported in 83 women (83%). Regarding mode of delivery, 83 women (83%) were delivered via spontaneous vaginal delivery (SVD), and 17 (17%) were delivered via lower segment Cesarean section (LSCS).

In the current study, induction time ranged from 4-18 hours with a mean value of 8.44 ± 3.15 hours and induction to delivery time ranged from 6-24 hours with a mean value of 12.16 ± 4.06 hours. The time from induction to delivery was <24 hr in 79 women (95.2%) and >24 hr in 4 women (4.8%).

Bishop score, CL, and PCA values in women with failed and successful IOL are shown in Tab. 1. A significant statistical difference was recorded between failed *vs.* successful induction outcomes concerning Bishop score, CL, and PCA ($P < 0.001^*$) (Tab. 1.).

ROC curves of Bishop score, CL, and PCA for predicting successful IOL were performed. The AUC of PCA was the highest (AUC 0.905, 95% CI 0.80 – 0.96). Also, PCA showed the greatest sensitivity, specificity, and accuracy as it was 92.0, 89.0, and 89.0, respectively (Tab. 2.).

ROC curves for combined CL and PCA, combined Bishop score and CL, and combined Bishop score and PCA were performed to predict successful IOL. The best prognostic combination was CL and PCA, showing a sensitivity of 94.0, specificity of 91.0, and accuracy of 91.0 (Tab. 2.).

DISCUSSION

IOL is indicated when labor is more beneficial than waiting for spontaneous labor [2]. Bishop score was introduced in practice as a predictor of successful IOL, and it is considered one of the most critical and valuable scoring systems [13]. However, as alternatives for the conventional Bishop score, some ultrasound parameters are recommended particularly, CL and PCA [14].

Tab. 1. Demographic, clinical, and ultrasonography characteristics of study group.

Characteristics	Successful IOL (n=83)	Unsuccessful IOL (n=9)	P Value
Age (year)	24.17 ± 3.94	24.67 ± 3.57	0.613
Body mass index b	26.10 ± 2.13	25.00 ± 1.58	0.569
Pregnancy duration (week)	38.77 ± 1.77	38.78 ± 1.20	0.831
Neonatal weight (gram)	3097 ± 447.2	3025 ± 456.1	0.550
Indication for IOL			
Post date	39	1	-
other	44	8	-
Bishop score	5.64 ± 1.14	3.11 ± .93	0.001
Cervical length	28.76 ± 3.93	34.67 ± 2.40	0.001
Posterior cervical angle	108.35 ± 17.94	91.56 ± 9.96	0.001
Oxytocin use	Yes	No	-

Tab. 2. Sensitivity, specificity, and accuracy of Bishop score, CL, PCL, (CL and PCA), (Bishop score and CL), and (Bishop score and PCA) to predict successful IOL.

	Area under the curve	P-value	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
Bishop score (Cut off value= 5)				
	0.781	0.0001*	0.632	0.911
Sensitivity		61.0		
Specificity		83.0		
PPV		64.0		
NPV		83.0		
Accuracy		78.0		
CL (Cut off value = 34.0)				
	0.877	0.0001*	0.786	0.942
Sensitivity		91.0		
Specificity		83.0		
PPV		86.0		
NPV		80.0		
Accuracy		86.0		
PCA (Cut off value = 99.0)				
	0.905	0.0001*	0.800	0.960
Sensitivity		92.0		
Specificity		89.0		
PPV		90.0		
NPV		88.0		
Accuracy		89.0		
CL and PCA				
	0.940	0.0001*	.823	.901
Sensitivity		94.0		
Specificity		91.0		
PPV		94.0		
NPV		95.0		
Accuracy		91.0		
Bishop score and CL				
	0.896	.001	.652	.817
Sensitivity		90.0		
Specificity		88.0		
PPV		91.0		
NPV		87.0		
Accuracy		89.0		
Bishop score and PCA				
	0.908	.0001*	.632	.805
Sensitivity		92.0		
Specificity		89.0		
PPV		91.0		
NPV		88.0		
Accuracy		90.0		

In the current study, PCA and the CL measurements were assessed using TVUS in comparison with the Bishop score to predict the effectiveness of IOL.

This study was conducted at Ain Shams University Maternity Hospital on 100 pregnant women admitted for IOL, aged from 18-39 years, with a mean of 24.17 ± 3.94 and with a gestational age of 37-41 weeks.

In this study, IOL failed in 17 cases (17%), out of which

8 cases (8%) had fetal distress. After IOL, 83 cases (83%) delivered via SVD, while 17 cases (17%) were delivered by LSCS.

Jing's study included 475 cases indicated for IOL. Out of all cases, 393 (82.7%) delivered vaginally, and 82 (17.3%) had CS. Forty women failed to access the active phase of labor, 20 had fetal hypoxia, additionally to other different causes [15].

That vaginal dose of 50- μ g of misoprostol was studied widely. Results demonstrated that such dose is more effective but not secure, unlike a 25- μ g dosage [16]. In the present study, up to five tablets of 25- μ g misoprostol tablets were used in the failed cases. While the successful cases used from 1-4 tablets.

As the cervical status before labor was identified as the most significant indicator of successful IOL, several studies have assessed the relation between the Bishop score and sonographic cervical measurement with IOL consequence [17,18].

In the current study, CL in failed IOL cases ranged from 29-37 with a mean value of 34.67 ± 2.40 while successful IOL cases ranged from 21-37 with a mean value of 28.76 ± 3.93 . For the prediction of successful IOL at cut-off 34 mm, the CL showed sensitivity, specificity, and accuracy of 91.0, 83.0, and 86.0, respectively, with PPV of 86.0 and NPV of 80.0.

The meta-analysis of Verhoeven's study involved 31 analyses that reported both CL and delivery outcome. For cesarean deliveries, summary estimates of both sensitivity/specificity for CL were 0.82/0.34, 0.64/0.74, and 0.13/0.95 for different cut-offs 20, 30, and 40 mm, respectively. They concluded that CL and cervical wedging by TVUS at or near term could predict the outcome of delivery after IOL [5].

Anikwe CC, et al. [18] Study reported that the mean induction delivery time for all participants was 8.1 ± 3.0 hours and a mean labor duration of 7.4 ± 2.9 hours. Pre-induction CL is a good predictor of a short labor duration ($P=0.001$).

In the present study, Bishop score ranged from 2-4 with a mean value of 3.11 ± 0.93 in failed cases, while in successful cases ranged from 3-8 with a mean value of 5.64 ± 1.14 . For the prediction of successful IOL, Bishop score at the cut-off point 5 demonstrated sensitivity, specificity, and accuracy of 90.0, 88.0, and 89.0, respectively, with PPV of 91.0 and NPV of 87.0. Thus, our study showed that the CL has better sensitivity, specificity, and accuracy in predicting successful IOL over Bishop score.

Kolkman's DG, et al. [19] study concluded that the Bishop score seems to be a weak predictor for IOL. In Bajpai N, et al. [20] study on 131 women who underwent IOL at term live fetuses, successful IOL was in 86.9% of patients. At cut-off values of ≥ 4 , TVUS cervical parameters were better than Bishop score (Sensitivity 77% *vs.* 65%, Specificity 93% *vs.* 86%) in predicting successful IOL. ROC analysis illustrated that AUC was higher for TVUS Score (0.90, 95% CI 0.84 – 0.95) compared to Bishop score. Also, Kanwar's SN, et al. [21] concluded that within 24 hours of IOL, CL is a powerful predictor of vaginal delivery in comparison to the modified Bishop score.

On the contrary to our results, Khandelwal R, et al. [22] study on 62 nulliparous women who underwent IOL

reported that the Bishop score had a higher significance (P -value <0.0001) than CL ($P=0.004$) in predicting the active phase of labor. Regarding Bishop score, the optimum cut-off point for predicting IOL through 6 hours was >4 , with a sensitivity of 69% and specificity of 79%. At the same time, the best CL's cut-off point for IOL prediction in 6 hours was <25 mm by 51% sensitivity and 70% specificity. In addition, for predicting induction-to-delivery interval within 12 hr, Bishop scores ($P=0.001$) were also superior to CL ($P=0.01$). Also, Bahadori F, et al. [23] found a more significant correlation of Bishop (0.001) than of CL (0.04) for predicting cervical ripening within 12 hours. The cut-off value for Bishop score was ≥ 4 , with a sensitivity and specificity of 57.9% and 28.7%, respectively, whereas the cut-off value for CL ≥ 19 mm had a sensitivity and a specificity of 66.7% and 65%, respectively.

In the current study, PCA in failed IOL cases ranged from 78-110 with a mean value of 91.56 ± 9.96 and in success IOL cases ranged from 70-150 with a mean value of 108.35 ± 17.94 . To predict the success of IOL at a cut-off value of 99.0, PCA presented sensitivity, specificity, and accuracy of 92, 89.0, and 89.0, respectively, with PPV of 90 and NPV of 88. In addition, PCA showed a significant negative correlation with induction time, induction to delivery and Vagiprost.

PCA $>99.5^\circ$, CL <34 mm, and a Bishop score >5 were suggested as cut-offs for the prediction of successful IOL by Al-Adwy AM, et al. [24]. There was no significant difference among the AUC of those three measurements. However, the PCA $>99.5^\circ$ had the highest sensitivity (91.84%), specificity (90.48), PPV (95.7%), and NPV (82.6%) comparing to the other two indicators.

The study conducted by Gokturk U, et al. [25] that included multi-variate regression analyses of variables showed that multiparity, CL, PCA, and Bishop score are good predictors for successful IOL.

Concerning the combination between parameters in our study, the combined CL and post PCA sensitivity, specificity, and accuracy to predict successful induction were 94.0, 91.0, 91.0, respectively. While Bishop score and CL sensitivity, specificity, and accuracy for predicting the success of induction were 90.0, 88.0, 89, respectively. In addition, the Bishop score and PCA's sensitivity, specificity, and accuracy for the prediction of successful induction were 92.0, 89.0, and 90, respectively.

Overall, PCA showed the best sensitivity and specificity as an indicator for IOL outcome, especially in combination with CL measurement.

CONCLUSION

Our data concluded that ultrasonographic cervical assessment and Bishop score are good indicators of successful IOL. Still, sonographic parameters including CL and PCA seemed to be better than the Bishop score in

predicting the outcome of labor induction, especially when used combined.

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DECLARATIONS

The authors report no conflict of interest.

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