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Cervical Length as a Predictor of Success of Induction of Labor in Term Pregnancy

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ABSTRACT
Background: Vaginal delivery is the most important event occurring in women's life. It carries many risks of significant concerns to the physicians. Predicting the chances of vaginal delivery is of paramount concern for the pregnant woman. Antenatal cervical length measurement has paramount importance in the prediction of labor.
Objective: This study aimed to study the role of cervical length in prediction of success of induction of labor in term pregnancy.
Patients and Methods: A prospective study where 140 pregnant women undergoing induction of labor for various indications were included, the cases were recruited from Obstetric Department of Shebin El-Kom Teaching Hospital in the period from October 2019 to December 2020.
Results: Methods of induction was misoprostol in (75) females and amniotomy with oxytocin in (65) females. 97 Females were delivered by simple vaginal delivery, 79 females were delivered within 24 hours of induction, 18 females were delivered after 24 hours, and 43 females were delivered by caesarian section (C.S.). Indications of C.S. were mainly due to failed induction and fetal distress.
C**onclusions:** We concluded that successful induction of labor was correlated significantly with detection of insulin-like growth factor-binding protein 1 (iGFBP-1) in cervical secretions and measurement of cervical length by transvaginal ultrasound (TVUS), IGFBP-1 detection by Actim Partus test is simple, easy bed side test that can predict successful induction of labor and measurement of cervical length by TVUS is a good predictor factor for successful induction of labor.
Keywords: Cervical, Induction of labor, Oxytocin, Transvaginal, Ultrasound, Uterine.

INTRODUCTION

Induction of labor is defined as an intervention designed to artificially initiate uterine contractions leading to progressive dilatation and effacement of the cervix and birth of the baby. Induction of labor is indicated when benefits to the mother or the fetus outweigh those of continuing the pregnancy such as post-dated pregnancy, premature rupture of the membranes before onset of labor, maternal diseases such as diabetes mellitus, hypertension with pregnancy, or fetal growth restriction, these are the most common indications for induction of labor [(1)]. Successful induction is reported to be related to cervical characteristics, "readiness or 'ripeness'. The traditional method of assessment of cervical ripeness is based on digital examination of the cervix. This scoring system described by Bishop in 1964 [(2)].

The uterine cervix undergoes considerable physiological, biochemical and anatomical changes during transition between the antenatal and intrapartum period. In primiparous women, cervical dilation and effacement were related to the time of gestation at which labor started[(3)]. The uterine cervix has been used as a predictor of the probability of vaginal delivery. Traditionally, the Bishop score has been used to assess. Bishop score consist of dilation, effacement, position, consistency of the cervix, and station of presenting part. Digital examination of the cervix is subjective and has considerable inter–observer variability. Furthermore only that portion of the cervix below the anterior vaginal wall is assessed [(4)].

Transvaginal ultrasonographic imaging measuring the cervical length is a good method for cervical assessment i.e., if the cervical length>30 mm and funneling (wedging) is > 30 percent of total cervical length this indicates an unripe cervix. Also, it might lead to a reduction in cesarean delivery and thereby its complications [(5)]. Rupture of membrane, separation (stripping) of membranes by fore fingers, massage of breasts, extra amniotic injection of prostaglandin solution and gel, introduction of catheter and administration of prostaglandins analogue; misoprostol (cytotec), misotac, vagiprost, antiprogestin; mifepristone (RU 486), oxytocin [(6)]. Today, Bishop score remains the standard method to predict the duration and outcome of induced labor. However, the preinduction 'favorability' of the cervix as assessed by the Bishop score is very subjective and several studies have demonstrated a poor predictive value for the outcome of induction especially in women with a low Bishop score [(7)].

Therefore, this study aimed to study the role of transvaginal ultrasound measurement of cervical length in prediction of success of induction of labor after 37 weeks of pregnancy.

PATIENTS AND METHODS

This is prospective cohort study. 140 pregnant women undergoing induction of labor for various indications were included, the cases were recruited from Obstetric Department of Menoufia University Hospital

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and Shebin El-Kom Teaching Hospital in the period from June 2020 to December 2020.
140 women were enrolled in this study, 97 of them were delivered by normal vaginal delivery, 71 of them were positive Actim Partus test, and 26 women were negative Actim Partus test. 43 women were delivered by C.S. 17 women were positive kites, 26 were negative test.

Inclusion criteria:

Women with singleton pregnancies after 37 weeks of gestation, women bearing a living fetus, fetuses with a cephalic presentation, no history of previous CS or myomectomy and intact membrane.

Exclusion criteria:

Women with multi fetal pregnancies, women diagnosed with mal presentations, intrauterine fetal death (IUFD), any degree of placenta previa and/or vasa previa, women diagnosed with a major degree of cephalopelvic disproportion by standard clinical tests, any non-reassuring CTG, women with active genital herpes or invasive cervical cancer, which contraindicated vaginal delivery, extreme low birth weight defined as less than1500 g, previous operations on the cervix (e.g. cautery, cervical amputation or conization), patients already in active labor on admission, premature rupture of membranes (PROM) and antepartum hemorrhage.
The primary outcome was induction success (defined as the ability to achieve the active phase of labor; cervical dilation more than or equal to 4 centimeter).
The secondary outcome was induction to delivery interval (IDI) and Apgar score of the newborn at 1 and 5 minutes. Using the definition of **Waston and Hubbard** [8] an induction attempt was considered successful if the patient reached the active phase of labor as demonstrated by progressive dilation and effacement of the cervix and followed by vaginal delivery. All women's data were recorded in a special input form.

In all cases, history, abdominal and vaginal examinations were done.

History; proper full history was taken including; **Personal history**: with special focus on maternal age, **Present history**: with special focus on duration of pregnancy from the first day of last menstrual period, warning symptoms as headache, visual symptoms, edema of the face and fingers, excessive vomiting, epigastric pain, pain the loin, watery vaginal discharge, vaginal bleeding, reduced fetal movements and edema of the lower limbs, ultrasound examinations and results, blood grouping and Rh typing, complete blood count, urine analysis and any medications, **Obstetric history**: Gravidity and parity, **Menstrual history:** 1st day of the last menstrual period.

Examination:

General examination: Full general examination was done with special concern to vital signs; Blood pressure, pulse, temperature and respiratory rate were noted and height, weight to calculate the BMI.
Abdominal examination: For assessment of fundal height, fetal lie and presentation, position of the back, fetal heart sounds, presence of uterine contractions, scar of previous surgeries, abdominal ultrasound was done by using abdominal probe 3.5MHZ of **LOGIQ V5** machine (China) for confirmation of fetal heart activity, presentation of the fetus, localization of the placenta, amount of amniotic fluid, fetal biometry to estimate gestational age and fetal weight and exclusion of multi fetal pregnancy and apparent congenital anomalies.

Sample size:

The sample size was calculated to be 140 women, according the formula, sample size (n) has been calculated based on specify = $Z^2_{1-\alpha/2}$ ×SP ×(1-SP) L2 × (1—Prevalence).

Ethical consent:

An approval of the study was obtained from Shebin El-Kom Teaching Hospital and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis:

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

This table shows the characters of the study group.

Table (1): General characteristics of the studied group (140 patients)

General characteristics	Participants	
	Mean ±SD	Range
Age (Y)	23.34 ±4.09	18-32
Weight (kg)	78.21 ±7.09	65-96
Height (cm)	163.05 ±5.97	153-180
BMI (kg/m^2)	29.12 ±2.57	23-37
GA (week)	39.85 ±1.41	38-42

In our study, the most common cause of induction of labor was postdate. Obstetric history of the studied group is shown in table 2.

Table (2): Present obstetric history of the studied group (140 patients)

Obstetric history	Participants	
	No	%
Indication for induction		
• Postdate	67	47.9
• PIH	40	28.6
• DM	33	23.6
Method of induction		
• Misoprostol	75	53.6
• Amniotomy and oxytocin	65	46.4
Mode of delivery		
• SVD	97	69.3
• CS	43	30.7
Vaginal delivery (no=97)		
• Within 24h	79	81.4
• >24 h	18	18.6
Indication for CS (no=43)		
• Failed induction	30	69.8
• Fetal distress	10	23.3
• Others	3	7.0

Table 3 shows the maternal and neonatal characteristics according to the mode of delivery.

Table (3): Comparison of the patient's characteristics according to the mode of delivery

	Mode of delivery				P value
	Vaginal No.=97		CS No.=43		
	Mean ±SD		Mean ±SD		
Maternal characteristics					
Age (Y)	23.34 ±4.13		23.35±4.05		**>0.05**
BMI (kg/m2)	29.06 ±2.51		29.26 ±2.70		**>0.05**
GA (w)	39.80 ±1.41		39.97±1.43		**>0.05**
Neonatal characteristics					
APGAR					
• 1 min	7.80 ±0.98		7.72 ±0.90		**>0.05**
• 5 min	8.08 ±0.94		8.13 ±1.08		**>0.05**
NICU: No, %					
• Yes	9	9.3	5	11.6	
• No	88	90.7	38	88.4	**>0.05**

The cervical length measured by transvaginal ultrasound was significantly longer with C.S. delivery than with vaginal delivery as shown in table 4.

Table (4): Comparison of the cervical length measured by transvaginal ultrasound according to mode of delivery

	Mode of delivery				**P value**	**OR CI95%**
	Vaginal No.=97		**CS No.=43**			
	No	**%**	**No**	**%**		
U/S cervical length Mean ±SD	24.89 ±5.48		26.79±3.06		0.04	-
Cervical length						
• ≤27	51	52.6	23	53.5	**>0.05**	1.0
• >27	46	47.4	20	46.5		0.96 (0.47-1.98)
Cervical length						
• ≤29	79	81.4	32	74.4	**>0.05**	1.0
• >29	18	18.6	11	25.6		1.51 (0.64-3.55)

A logistic regression was performed to ascertain the effects of cervical length on the likelihood that participants have C.S. The logistic regression model was statistically significant ($p < 0.001$). The model explained 32.0% (Nagelkerke R2) of the variance in CS and correctly classified 75.0% of cases (Table 5).

Table (5): Binary logistic regression for predictors of mode of delivery

	OR	**P value**	**95% CI**	
			Lower	**Upper**
Cervical length (>27)	0.37	0.086	0.12	1.15
Cervical length (>29)	1.18	0.796	0.33	4.21

In our study, sensitivity, specificity, Accuracy, PPV, and NPV of cervical length to predict vaginal delivery within 24 hours are shown in table 6 and within more than 24 hours are shown in table 7.

Table (6): Validity of cervical length by transvaginal ultrasound in the prediction of vaginal delivery within 24 hours

	Cutoff value	**Sensitivity**	**Specificity**	**Accuracy**	**PPV**	**NPV**
Cervical length	**≤27mm**	0.62 0.50-0.73	0.89 0.64-0.98	0.67 0.57-0.76	0.96 0.85-0.99	0.35 0.22-0.50
Cervical length	**≤29mm**	0.81 0.70-0.89	0.23 0.14-0.36	0.56 0.47-0.64	0.58 0.48-0.67	0.48 0.30-0.67

Table (7): Validity of cervical length by transvaginal ultrasound in the prediction of vaginal delivery > 24 hours

	Sensitivity	**Specificity**	**Accuracy**	**PPV**	**NPV**
Cervical length (≤27mm)	0.11 0.02-0.36	0.38 0.27-0.50	0.33 0.24-0.43	0.04 0.01-0.15	0.65 0.50-0.78
Cervical length (≤29mm)	0.83 0.58-0.96	0.19 0.11-0.30	0.31 0.22-0.41	0.19 0.11-0.30	0.83 0.58-0.96

DISCUSSION

The aim of this study was to compare between pre induction ultrasonographic measurement of cervical length and detection of IGFBP-1 in cervical secretions by Actim Partus test in prediction of successful induction of labor. In this study, 140 pregnant women 37-42weeks gestational age undergoing induction of labor due to pregnancy-induced hypertension (PIH), gestational diabetes or passed date.

These results were in agreement with that of **Vallikkannu *et al.*** [9] who studied 193 women term nulliparous women with intact membranes, prior to labor induction, cervical fluid was obtained via a vaginal speculum and tested for IGFBP-1 (Actim Partus test Medix Biochemical), followed by TVUS and finally Bishop score. After each assessment the procedure related pain was scored from 0 to 10. Cutoff values for Bishop score and cervical length were obtained from the receiver operating characteristic (ROC) curve. Multivariable logistic regression analysis was performed.

Our study is not consistent with **Cheung *et al.*** [10] who studied 460 women at 37-41 weeks of gestations to determined cervical length (CL), posterior cervical angle (PCA) and the fetal occipital position. the Bishop score (BS) and the absence/presence of IGFBP-1 in cervical secretions. A total of 340 (73.9%) women achieved vaginal delivery following induction. Multivariate analysis indicated that significant independent predictors of vaginal delivery were CL (adjust odd ratio (AOR) 0.59, 95% confidence interval (CI); 0.45-0.79), PCA (AOR; 1.89, 95% CL; 1.09-3.28) and multiparae (AOR; 10.02, 95% CL; 5.10-19.69). For a specificity of 75%, the sensitivity for prediction of vaginal delivery using the Bishop score, the cervical length and the multivariate model using the identified significant independent predictors were 37.1, 46.8 and 68% respectively.

After assessment, they found that the combination of TVUS measurement of the cervical length and maternal characteristic was superior to either Bishop score or TVUS cervical length alone in prediction of the induction outcome. The inclusion of IGFBP-1 didn't further improve prediction in their model. Their finding is in sharp contrast to ours, and the difference may result because of the mixed population of nulliparous (61%) and parous (39%) women in their study. Also, 72% of their participants had their labor, induced because of prolonged pregnancy. In contrast, our participants were exclusively nulliparous and only 47.9% had labor induction for prolonged pregnancy.

Our results were inconsistent with **Groeneveld *et al.*** [11] who evaluated TVUS measurement of the cervical length versus the Bishop score, prior to induction of labor, for predicting the mode of delivery within four days, by studying 110 in whom induction of labor was performed at 37-42weeks of gestation. The agents used for induction were dinoprostone gel on the first 2 days and, if necessary, misoprostol tablets intravaginally on the third or fourth day. The maximum dose of dinoprostone in 24 hours was 3 mg given in two doses. On the third and fourth day a maximum of 75 microgram misoprostol in 24 hours could be applied intravaginally in three doses at interval. Primary outcome criterion was successful vaginal delivery within 96 hours. Of the 110 women 66 were nulliparous and 44 multiparous. Vaginal delivery within 96 hours was successful in 48 (73%) nulliparous and in 40 (91%) multiparous women (i.e. in 80% of the total population). The overall rate of caesarean delivery was 17%.

Only the Bishop score in nulliparous women showed a significant relationship between this variable and predicting successful labor induction (area under the ROC curve 0.679; standard error 0.73; $p<0.05$; 95% CL; 0.536-0.823). The best cutoff value for the Bishop score was 3, with a sensitivity of 56.3% and a specificity of 72.2%. TVUS measurement of cervical length wasn't a significant independent predictor of vaginal delivery within 96 hours.

This disagreed with our results as they chose a longer interval (96 hours) between start of induction and vaginal delivery in order to avoid caesarean delivery as much as possible. Their caesarean delivery rate was 17.3% compared with 30.7% in our study. But that long period may be considered extra burden on the participants comparing with our interval (48 hours) as prolonged trial of labor lead to maternal exhaustion and longer hospitalization with consequent increased morbidity and financial cost and also, they included nulliparous and multiparous women.

Our results are inconsistent with **Chandra *et al.*** [12] who studied 122 women with postdate pregnancy where TVUS measurement of cervical length and digital vaginal examination were performed immediately before labor induction. Ultrasound assessment of cervical length, dilation, and presence of funneling were compared with the components of the Bishop score. They found no ultrasound characteristic predicted successful vaginal delivery and Bishop score, cervical position and maternal age independently predicted vaginal delivery. In our study population, the multiple indications for induction of labor might explain the differences between these two studies.

Also inconsistent with **Reis *et al.*** [13] who studied 134 women undergoing labor induction at term caused by several obstetric conditions. All participants were submitted to digital examination and TVUS for measurement of the cervical length and detection of funneling. Only obstetric history and digital examination predicted accurately vaginal delivery within 24 hours and were independently associated with labor duration. Ultrasound measurements of cervical length failed to predict accurately the outcome of induced labor.

CONCLUSION

We concluded that successful induction of labor was correlated significantly with detection of insulin-like growth factor-binding protein 1 (iGFBP-1) in cervical secretions and measurement of cervical length by transvaginal ultrasound (TVUS), IGFBP-1 detection by Actim Partus test is simple, easy bed side test that can predict successful induction of labor and measurement of cervical length by TVUS is a good predictor factor for successful induction of labor.

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