Predicting factors on cervical ripening and response to induction in women pregnant over 37 weeks

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Abstract: Induction of labor is a widely used intervention on the modern labor. The Bishop score, since its description in 1964, remains the gold standard for assessing favorability for induction of 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. **The aim of this study** was to evaluate whole the predicting factors mainly the Transvaginal ultrasonographic measurements and a new score proposed by Kepanasereel et al. in 2012 combining parity and ultrasonographic measurements in predicting the success of induction of labor. **Patients and Methods**: In our study 70 women 37-42 weeks pregnancy underwent induction of labor. Before induction a digital examination of the cervix was performed & the Bishop score noted. Cervical length, posterior cervical angel & cervical funneling were then measured by a transvaginal ultrasound & the Kepansereel score noted. **Results**: The mean cervical length. in patients delivered vaginally while the mean cervical length in patients delivered by C.S. was 35y was 27± 6 mm ± 6 mm The mean posterior cervical angel in patients delivered vaginally was 99.2± 13.9 degrees while the mean posterior cervical angel in patients delivered by C.S. was 94.2± 8 degrees. **conclusion:** a statistically significant positive correlation between cervical length & posterior cervical angel measured by ultrasound and failure of induction and probability of C.S. & a statistically significant negative correlation between both scores (Bishop & Kepansereel) and failure of induction and probability of C.S. Successful induction correlated significantly with the Bishop score and ultrasonographically measured. cervical length, posterior cervical angel and successful vaginal delivery.
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1. Introduction

Induction of labour is a common Obstetric practice which refers to the process where the uterine contractions are initiated by medical and surgical means before the onset of spontaneous labou (1***).*** Induction of labour is indicated in about 20% of term pregnancies and is associated with a caesarean delivery rate of about 20% ***(2).*** The commonly cited indications for induction of labour are premature rupture of membranes before onset of labour, diseases as diabetes mellitus or hypertension with pregnancy, intrauterine growth restriction or pregnancy passing 41 weeks, which is most common indication ***(3).*** Prolonged pregnancy is a real problem in modern obstetrics. It causes anxiety and distress for many women, their families and obstetricians. This may be exacerbated by poor counseling ***(4).*** There is no obvious cause for the prolongation of pregnancy as the onset of labour is not fully understood. There is no consensus about the exact definition of prolonged pregnancy. Most authors depend on the completed 41 weeks of gestation from the first day of last menstrual regular period. The prolonged pregnancy accounts for 10% of all pregnancies. Incidence of prolonged pregnancy decreased with the use of ultrasound early in pregnancy avoiding false dating. A pregnancy becomes at risk at the end of 41 weeks of amenorrhea ***(5).*** Prolonged pregnancy carries many problems for pregnancy, labour and fetal outcome, namely; oligohydramnios (which may be indicator of poor placental reserve), meconium stained liquor (with the potential danger of meconium aspiration), post-partum macrosomia with shoulder dystocia with the possibility of obstructed labour, fetal distress during labour and increased perinatal morbidity and mortality ***(6)*** There are various methods for induction of labour including; rupture of membrane, separation (stripping) of membranes by forefinger, massage of breasts, extra amniotic injection of prostaglandin solution and gel, introduction of catheter ***(7) &*** administration of prostaglandins, prostaglandins analogue; misoprostol (cytotec), misotac, vagiprost, antiprogestin: Mifepristone (RU 486), oxytocin ***(8).***

Induction of labour is associated with many disadvantages e.g misoprostol has been associated with an increased incidence of tachysystole ***(9).*** Also the incidence of meconium staining was found in some studies to be higher with misoprostol ***(10)*** Oxytocin is close to vasopressin in structure and has an antidiuretic effect when given in high dosages (40

mIU per min); thus, water intoxication is a possibility in prolonged induction. Uterine hyperstimulation and uterine rupture can also occur as well as uteroplacental insufficiency and fetal hypoxia. This outcome underscores the importance of continuous fetal heart rate monitoring ***(11).*** The uterine cervix undergoes considerable physiological, biochemical and anatomical changes during the transition between the antenatal and intrapartum period. In primiparous women, cervical dilatation and effacement were related to the time of gestation at which labour started ***(12).*** Assessment of the cervix has been used as a predictor of the probability of vaginal delivery. Traditionally, the Bishop score has been used to assess the cervix. Bishop Score consist of (Dilatation, effacement, position, consistency of the cervix, and station of presenting part) ***(13).*** 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 (***14).*** Although induction of labour is a safe and efficacious method of vaginal delivery, it still carries considerable risk of caesarean delivery compared with spontaneous labour, and this risk is significantly influenced by the status of the cervix at the time of labour induction (***15***). Transvaginal ultrasound has been proposed as a better predictor of the success of labour compared with the Bishop score ***(16).***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 ***(17).***However it has been reported that transvaginal ultrasound has been proposed as a better predictor of success of labour compared with the Bishop score ***(18)*** and better prediction of the risk of cesarean section after induction of labour than Bishop score ***(19).***

The aim of the study to detect the parameter which can predict cervical ripening and successful induction in term pregnancies.

2. Material and methods

In this study, 70 pregnant women undergoing induction of labour for various indications were included. Inclusion criteria: Women with singleton pregnancies over 37 weeks, Women bearing a living fetus, Fetuses with a cephalic presentation, No history of previous CS or myomectomy. Exclusion citeria: Women with multifetal pregnancies. Women diagnosed with malpresentations. IUFD. Any degree of placenta previa and/or vasaprevia. 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 contraindicate vaginal delivery. Extreme low birth weight defined as <1500g. Previous operations on the cervix (e.g. cautery, cerclage, cervical amputation or conization) Patients already in active labor on admission.

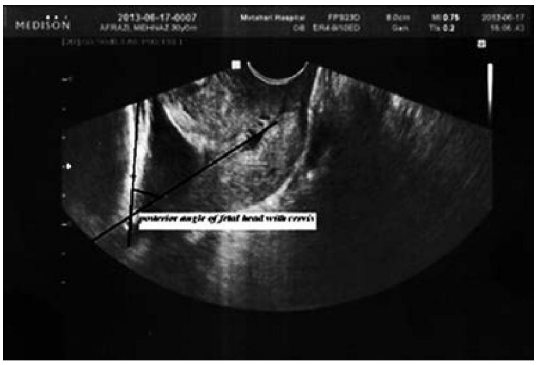

Figure (1): Posterior angle calculation during cervical length measurement

-Vaginal examination**:** To assess the Bishop score of the cervix, to exclude cephalopelvic disproportion, confirm presentation, position and detection of head station and to exclude contraindications of vaginal delivery. Transvaginal U/S: was done for cervical length measurement. We asked the patient to empty her bladder. The transvaginal probe was inserted into the vagina and rocked in the antero-posterior direction to visualize the cervix. We visualized the line of the internal cervical canal. We checked that the anterior and posterior lips of the cervix appear equal. Then we slowly withdrew the probe a little and slide back to make sure there is no compression artifact. The measurement was repeated three times and we recorded the average. **A.** The cervical length was measured from internal to external os. **B**. Any funneling was recorded and funneling percentage was calculated as follows: Percentage of funneling = A/(A + B) where A is Funnel length (length of the imaginary line that connects the apex of the funnel to the cranial most edge of the base of the funnel) and B is residual or functional cervical length (cervical length distal to the funnel). **C**. Posterior cervical angle is measured in a sagittal plane at the level of the internal os, as the angle between an imaginary line traversing the cervical canal and another tangential to the posterior uterine wall at its junction with the internal os. Values will be approximated to the nearest degree. In case of a funneled or an excessively curved cervix, the angle will be assessed at the junction of the line measuring the cervical length and the posterior uterine wall.

Labor induction**:** Induction of labor was done according to standard guidelines for induction of labor as follows:-1) Prostaglandin E1, (misoprostol): Started for unfavorable cervices with a Bishop score <7**,**

Initial dose 25 microgram vaginal tablet (**vagiprost®** 25 microgram manufactured by ADWIA CO. S.A.E Egypt). Full reassessment 6 hours after initial dose unless clinical condition indicates earlier assessment. Second dose 25 micrograms in cases with unfavorable cervix.

Reassessment every 6 hours later and re-dosing if cervix was still unfavorable. If no cervical ripening after 4 doses of misoprostol, the procedure was considered a failure and the patient was delivered by Caesarean section. If there is cervical ripening we moved to the next step.2) Oxytocin and/or Amniotomy: Oxytocin infusion was started by 5 units in 500 ml of normal saline or "Ringer's solution" 6 hours following the last dose of misoprostol starting with a rate of 12 drops/minute. Infusion rate was increased (by doubling drops/minute) at intervals of 30 minutes, until there are 3 good contractions in 10 minutes, each lasting 45-60 seconds. Maximum allowed rate was 84 drops/ minute**.** During the period of induction, the fetal heart rate was monitored continuously, by means of electronic fetal heart rate monitoring (Cardiotocography). Also, maternal monitoring was done including blood pressure measurements every 2 hours and frequent clinical evaluation (according to the condition). All patients received intrapartum analgesia during the period of induction in the form of pethidine 50 mg/4 hourly IM upon patient request. Deliveries were performed in the operating theater and a pediatrician and anesthetist were attending. All patients who delivered vaginally received active management of third stage of labor.

3. Results

49 pregnant women were delivered vaginally and 21 were delivered by caesarian section. Indications of C.S. were failed induction (patient received 4 doses of misoprostol 25 microgram with 6 hours interval and no cervical dilatation & effacement were noted), failure to progress, fetal distress or abruption placentae. In this study, 28 women were Primigravida and 42 women were multipara.60.7 % of primigravidas delivered vaginally and 39.3 % of them delivered by C.S.66.6 % of multipara delivered vaginally and 33.4 % of them delivered by C.S.

It was found that parity is non significantly correlated to successful induction (p value 0.156). The mean age of patients delivered vaginally was 23± 4.9 and the mean age of patients delivered by C.S. was 27.2± 6.6. The mean BMI of patients delivered vaginally was 29.2± 3.8 and the mean BMI of patients delivered by C.S. was 29.2± 3.8. The mean gestational age of patients delivered vaginally was 38.8± 1.9 and the mean gestational age of patients delivered by C.S. was 39.0± 2.2. The mean fetal birth weight of babies delivered vaginally was 3221±394 gms and the The mean fetal birth weight of babies delivered by C.S. was 3616 ± 632. There was no statistically significant correlation between age, height, BMI or gestational age and success of induction of labour.

Table (1): Mode of delivery and percentage

Mode of delivery	Number	Percentage %
CS	21	30%
VD	49	70%

Table (2): Parity and mode of delivery:

	V.D	C.S.	Total	*p*. value
Primigravida	17 (60.7%)	11 (39.3%)	28	
Multipara	28 (66.6%)	14 (33.4%)	42	0.156

Table (3): Relation between clinical data and outcome (success of induction)

	V.D	C.S	P. value
Age	23± 4.9 yrs	27.2± 6.6 yrs	0.438
Height	164.8± 9.9 cm	163.3± 9.6 cm	0.633
BMI	29.2± 3.8	29.3± 5.8	0.921
Gestational age	38.8± 1.9 wks	39.0± 2.2 wks	0.776
Neonatal birth Weight (gm)	3221±394 gm	3616 ± 632 gm	0.010

Table (4): Bishop score and ultrasonographic criteria:

	V.D.	C.S.	*P*. value
Bishop score	4.4± 1.3	3.2± 1.1	>0.001
Kepansereel Score	6.4 ± 3.3	3.9 ± 3.1	>0.001
Cervical length (mm)	27± 6 mm	35± 6 mm	>0.001
Posterior Cervical Angel	99.2± 13.9	94.2± 8	>0.001
Percentage of Funneling	8.3± 10 %	4±7.6 %	>0.163

The mean cervical length in patients delivered vaginally was 27± 6 mm while the mean cervical length in patients delivered by C.S. was 35± 6 mm.

The mean posterior cervical angel in patients

delivered vaginally was 99.2± 13.9 degrees while the mean posterior cervical angelin patients delivered by C.S. was 94.2± 8 degrees.

The mean percentage of funnelling in patients delivered vaginally was 8.3± 10 percent while the mean percentage of funnelling in patients delivered by C.S. was 4±7.6 percent.The mean Bishop score in patients delivered vaginally was 4.4± 1.3 while The mean Bishop score in patients delivered by C.S. was 3.2± 1.1. The mean Kepansereel score in patients delivered vaginally was 6.4 ± 3.3 while The mean Kepansereel score in patients delivered by C.S. was 3.9 ± 3.1.

4. Discussion:

To date, 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 ***(20).***

Transvaginal ultrasonographic measurement of cervical length may be a more objective method for assessing cervical status ***(21-22).*** The aim of this study was to determine the relationship between preinduction ultrasonographic measurements and Bishop score in comparison in the prediction of successful vaginal delivery. In this study, 70 pregnant women 37-42 weeks gestational age undergoing induction of labour due to PIH, gestational diabetes, ROM or passed date using 25µg misopristol vaginally. The dose was repeated at 6 hours interval for maximum 24 hours. In our study (70%) of our 70 participants were delivered vaginally and (30%) women were delivered by C.S. Bishop score, ultrasonographic measured cervical length, posterior cervical angle and Kepansereel score provided independent contribution in the prediction of the likelihood of delivering vaginally within 48 h. The present study found that successful induction of labour correlated significantly with the Bishop score ($p < 0.001$), The posterior cervical angel ($p<0.001$), ultrasonographic cervical length ($p < 0.001$) & Kepansereel score ($p<0.001$). **Kepanasereel et al (23)** studied 311 women undergoing induction of labour for the formulation of a new score, which will be more objective than the conventional Bishop's score. Labour induction was successful in 79.09%. A new score was formulated using the parameters having independent association and weighting of individual components was given according to its regression coefficients. The best cut-off point for the Bishop' s score was 5 & the best cut-off point new score in receiver operating characteristics curve was 6 with a sensitivity of 95.5% and specificity of 84.6%. The new score was found to have a better area under the curve than the conventional score. The new score of 6 had a sensitivity of 95.5%, and specificity of 84.6%, and a Bishop' sscore of 5 with 65.3% and 80.8%, respectively.

Yang et al (24) studied induction of labour in 105 women. The most common reason for induction was postterm pregnancy of 41completed weeks or more followed by a large-for-gestational-age fetus. And they found that successful induction correlated significantly with the Bishop Score and cervical length. Maternal age and gestational age were not significant predictive factors.

Peregrine et al (25) found same results when they studied induction of labour in 267 women at 36 or more weeks of gestation immediately before induction of labor. Logistic regression analysis was used to determine which factors best predicted the risk of cesarean delivery. They found that Parity ($p <$ o.oo1), body mass index ($p <$ o.oo1), height ($p =.005$), and ultrasonic transvaginal cervical length ($p <$ o.oo1) are the most accurate parameters in predicting the risk of cesarean delivery after induction of labor.

Groeneveld et al (26) evaluated transvaginal ultrasonographic measurement of the cervical length versus the Bishop score, prior to induction of labour, in predicting the mode of delivery within four days. *By* studying 110 in whom induction of labour was performed at 37-42 weeks of gestation. The agents used for induction were dinoprostone gel on the first 2 days and, if necessary, misoprostol tablets intravaginal on the third or fourth day. The maximum dose of dinoprostone in 24 h was 3 mg given in two doses. On the third and fourth day a maximum of 75 µg misoprostol in 24 h could be applied intravaginally in three doses at intervals. Primary outcome criterion was successful vaginal delivery within 96 h. Of the 110 women 66 were nulliparous and 44 multiparous. Vaginal delivery within 96 h 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 labour induction (area under the ROC curve 0.679; standard error 0.73; $p < 0.05$; 95% CI: 0.536-0.823). The best cut-off value for the Bishop score was 3, with a sensitivity of 56.3% and a specificity of 72.2%. Transvaginal ultrasonographic measurement of cervical length was not a significant independent predictor of vaginal delivery within 96 h. This disagreed with our result as they chose a longer interval (96h) 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% in our study. But that long period

may be considered extra burden on the participants comparing with our interval 48h as prolonged trial of labour leads to maternal exhaustion and longer hospitalization with consequent increased morbidity and financial cost.

Bastani et al (27) studied 200 women with singleton pregnancies undergoing induction of labor at 37–42 weeks. Transvaginal ultrasound was done for all participants prior to induction. To compare the predictive value of the methods, receiver-operating characteristic (ROC) curves were plotted and equality of the area under curve (AUC) was tested. The AUC calculated for Bishop score was 0.39 (95% confidence interval [CI] 0.3–0.48). The AUC for cervical length measured by ultrasonography was 0.69 (95% CI 0.6–0.77). Testing equality of the ROC curves for these two methods showed the ROC for cervical length to be statistically different from Bishop score ($P < 0.001$). Agreeing with our results they found cervical length measured by transvaginal ultrasonography has the potential to replace the traditional Bishop score, provided that such a facility is available when needed.

Laencina et al (28) assessed Bishop Score by digital examination and measured cervical length by transvaginal ultrasonography in 177 women with a single pregnancy, 36–42 weeks of gestation, and a live fetus in cephalic presentation before induction of labor with both prostaglandin and oxytocin. Similar to our results they found that the Bishop Score, cervical length, and parity provided independent contribution in the prediction of the likelihood of delivering vaginally within 60h. The best cut-off points for predicting successful induction using receiver operating characteristic curves were 24mm (30mm in our study) for cervical length and 4 (>5 in our result) for the Bishop score. Also Cervical length was a better predictor than the Bishop score (sensitivity and specificity of 66 and 77% versus 77 and 56%, respectively).

Tan et al (29) in their prospective study that was performed on 249 women admitted for labor induction. They found that analysis of the ROC curves for cervical length and Bishop Score indicated that both were predictors of Cesarean delivery (area under the curve 0.611 vs. 0.607; P = 0.012 vs. P = 0.015, respectively) with optimal cut offs for predicting Cesarean delivery of >20 mm for cervical length and Bishop score ≤5. Cervical length had superior sensitivity (80% vs. 64%) and marginally better positive (30% vs. 27%) and negative (89% vs. 83%) predictive values. Moreover they found that Transvaginal sonography was significantly less painful than digital examination for Bishop Score assessment.

Bueno et al (30) analyzed the clinical and sonographic variables that affect the success of labor induction. Bishop score, cervical length, and parity were studied in 196 pregnant women in the prediction of successful vaginal delivery within 24 hr of induction. the best statistic sequence that predicts the labor induction was found when we introduced parity in the first place. Cervical length and Bishop predicted the success of labor induction equally.

Chandra et al (31) studied 122 women with post date pregnancy where Transvaginal ultrasound and digital vaginal examinations were performed immediately before labor induction. Ultrasound assessments of cervical length, dilatation, 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 labour might explain the differences between these two studies.

Reis et al (32) enrolled prospectively 134 women undergoing labor induction at term caused by several obstetric conditions. All participants submitted to digital examination, and transvaginal ultrasound 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.

A potential limitation of our study was the inclusion of a heterogeneous group of patients with regard to the indication for medical induction at different gestational ages, ranging from 35to 42 weeks of gestation. Indeed, cervical ripening is a dynamic process, with changes occurring late in the third trimester r before the onset of labour ***(33)***. Therefore, the performance of sonographic cervical measurement might be different according to gestational age or indication.

Limits of the study:

Beside all the results which were found in this study, there were just few probable factors which have to be taken into account, Also this study would have been more reliable if it was conducted on a larger population.

Conclusion:

In this study we found that successful induction correlated significantly with the Bishop score and ultrasonographic cervical length & posterior cervical angel. We suggest that a better prediction of the outcome of labour can be achieved by Kepansereel Score which is a more objective scoring.

BMI, and parity are not predicting factors for natural delivery although these factors are good

predictors for cervical ripening. Our study shows that predicting cervical ripening or reaching active phase could be different from predicting the final vaginal delivery. On the other hand regarding the lack of routine measurement of the posterior angle for predicting the delivery process, it would be possible to propose a solution for predicting final delivery results by continuing this study and conducting supplementary researches.

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