

Comparative Study between 2D and 3D Ultrasound Cervicometry and Digital Assessment of the Cervix before Induction of Labour

Yahia A. Wafa¹, Nabil F. Mohamed², Mohamed S. Abouzeid^{1*}

¹Department of Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University

²Department of Obstetrics and Gynecology, Al-Agoza Police Hospital

*Corresponding author: Mohamed S. Abouzeid; Mobile: 01003324095; Email: tahasaber49@gmail.com

ABSTRACT

Background: labor is the physiological process by which the fetus is expelled from the uterus to the outside world. It is defined as increase in myometrial activity or more precisely, a switch in the myometrial contractility pattern from contractures (long-lasting, low-frequency activity) to contractions (frequent, high intensity, high frequency activity), resulting in effacement and dilatation of the uterine cervix.

Aim of the Work: this study aimed to compare between 2D and 3D ultrasound cervicometry and digital assessment of the cervix before induction of labor.

Patients and Methods: this study was carried out at Obstetrics and Gynecology Departments of Al-Hussien University Hospital and Al-Agoza Police Hospital from July 2016 to January 2018 on one hundred (100) women; their ages ranged from 18 to 35 years and the gestational ages ranged from 37-42 weeks. All patients had medical indications for labor induction.

Results: there were highly statistically significant relations (**HS**) between mode of delivery and cervical length, bishop score and posterior cervical angle as p value (**0.001**). It was found that the more obtuse the angle, the higher the probability of vaginal delivery and the reverse for the cervical length. This means that Bishop Score and cervical length and posterior cervical angle had the same dependency in predicting successful labor induction.

Conclusion: in this study we found that the successful induction correlated significantly with transvaginal ultrasonographic measurements of the posterior cervical angle and cervical length and Bishop Score. But, Bishop Score appeared to be specific and accurate than the ultrasonographic measurements in prediction of successful vaginal delivery.

Recommendations: further studies on large number of participant with the same indication of induction and the same gestational age are recommended to assess Bishop Score and transvaginal ultrasonographic measurements and to evaluate each of them as predictors of successful labor induction.

Keywords: 2D and 3D ultrasound, cervicometry, digital assessment, cervix, induction of labour.

INTRODUCTION

Prolonged pregnancy is a real problem in modern obstetrics. It causes an anxiety among pregnant women ⁽¹⁾. In a United Kingdom study, undelivered women at 41 weeks gestation had a significantly higher anxiety score than women who had delivered ⁽²⁾.

According to the World Health Organization (WHO), the definition of post-term pregnancy is the pregnancy that had extended to or beyond 42 weeks (294 days) of gestation ⁽³⁾. Prolonged gestation complicates 5% to 10% of all pregnancies and confers increased risk to both the fetus and mother ⁽⁴⁾.

Post term pregnancy is a pregnancy that extends to 42 weeks of gestation or beyond. Fetal, neonatal and maternal complications associated with this condition have always been underestimated. It is not well understood why some women become post term although in obesity, hormonal and genetic factors have been implicated.

The management of post term pregnancy constitutes a challenge to clinicians. Knowing who to induce, who will respond to induction and who will require a caesarean section (CS) ⁽⁵⁾. Post term pregnancy is associated with higher rates of stillbirth, macrosomia (birth weight > 4000g), birth injury and meconium aspiration syndrome ⁽⁴⁾.

The management of prolonged pregnancy remains controversial. Despite many trials, there is still no consensus regarding the most appropriate management of this difficult situation, thus in many instances the decision as whether to intervene in prolonged pregnancy is based on tradition and emotion rather than scientific data ⁽⁶⁾.

Ultrasonographic measurements as the cervical length, the fetal occiput position, the estimated fetal weight and whether the head is well flexed or not are good predictors for successful labor induction in prolonged in primigravidas ⁽⁷⁾.

Induction of labor is indicated when benefits to the mother or the fetus outweigh those

of continuing the pregnancy such as post-dated pregnancy, preeclampsia or fetal growth restriction⁽⁸⁾.

Induction of labor is performed in about 20% of all pregnancies and successful induction is reported to be related to cervical characteristics, or 'ripeness'⁽⁹⁾.

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 a study had demonstrated a poor predictive value for the outcome of induction especially in women with a low Bishop score⁽¹⁰⁾.

The Bishop score is a poor predictor for the outcome of induced labor at term and should not be used to decide whether to induce labor or not⁽¹¹⁾. In women underwent induction of labor, pre-induction sonographic assessment of cervical length and occipital position were superior to the Bishop score in the prediction of outcome of labor^(12,13).

Using pre-induction sonographic and maternal characteristics to predict the outcome of induction enables the clinician to provide precise information to the mothers and accordingly plan further management of the pregnancy⁽¹²⁾, also might lead to a reduction in caesarean delivery and therapy its complications⁽¹⁴⁾. Induction of labor at 41 weeks was associated with less intrapartum fetal compromise, meconium-stained liquor (MSL) and macrosomia (>4,000 gm)⁽¹⁵⁾.

AIM OF THE WORK

This study aimed to compare between 2D and 3D ultrasound cervicometry and digital assessment of the cervix before induction of labor.

PATIENTS AND METHODS

This study was carried out at Obstetrics and Gynecology Departments of Al-Hussien University Hospital and Al-Agoza Police Hospital from July 2016 to January 2018 on one hundred (100) women their ages ranged from 18 to 35 years and gestational ages ranged from 37-42 weeks. All patients had medical indications for labor induction.

The study was approved by the Ethics Board of Al-Azhar University.

Patient selection and inclusion criteria:

1. Written consent always preceded inclusion.
2. Every pregnant lady must have an accurate estimation of gestational age.

3. Women with singleton pregnancies, vertex presentation and intact membrane.
4. Indications for labor induction were:
 - a. Pregnancy induced hypertension (PIH).
 - b. Diabetes mellitus (DM).
 - c. Indication for termination of pregnancy is prolonged pregnancy >41.
 - d. IUGR.
 - e. Other medical conditions (ex: renal disease, Cardiac disease).
 - f. All cases were not in labor on admission.
 - g. Bishop score ≤ 5.

Exclusion criteria:

1. Contraindication for vaginal delivery e.g. uterine scar.
2. Multiple pregnancies.
3. Patient who is unsure of her dates.
4. Pregnant patients with dead fetus or fetus with congenital anomalies.
5. Previous operations on the cervix (e.g. cautery, cerclage, cervical amputation or conization).
6. Obsteric or medical complications of pregnancy e.g. DM or HTN.
7. Any medication in pregnancy except vitamins and tonics.

Written consent was obtained from each patient after explaining the full procedure.

Sample Size:

In this study, 100 pregnant women were included.

Medical Consideration:

Patient information and informed consent

Before being admitted to clinical study, the patient had to consent to participate after the nature, scope and possible consequences of the study have been explained in an understandable form by the researcher themselves.

Confidentiality:

Only the patient's initials were recorded and if the patient's name appears on any other document it was kept in privacy by the researcher.

Institutional Review Board (IRB) approval:

The clinical research study was conducted in accordance with the current IRB-approval clinical: International Conference on Harmonisation and Good Clinical Practice (ICH GCP) Guidelines and relevant politics, requirements and regulations of Obstetrics and

Gynecology Department, Faculty of Medicine,
Al Azhar University.

Methods:

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

1-History:

Proper full history was taken including:

Personal history: with special focus on maternal age.

Present History:

- (a) Duration of pregnancy from the first day of last menstrual period.
- (b) Warning symptoms as headache, visual symptoms, edema of the face and fingers, excessive vomiting, epigastric pain, pain in the loin, watery vaginal discharge, vaginal bleeding, reduced fetal movements and edema of the lower limbs.
- (c) Ultrasound examinations and results.
- (d) Blood grouping and Rh typing.
- (e) Complete blood count, urine analysis, fasting blood glucose or glucose tolerance test.
- (f) Any medications.

Obstetric history:

- (a) Gravidity and Parity.
- (b) Any associated complaint during this pregnancy, especially vaginal bleeding and abdominal pain.

Menstrual history:

Table 1: Bishop scoring system used for assessment of inducibility

Score	Dilatation (cm)	Effacement (%)	Station (-3 to +3)	Cervical consistency	Cervical position
0	Closed	0-30	-3	Firm	Posterior
1	1-2	40-50	-2	Medium	Midposition
2	3-4	60-70	-1	Soft	Anterior
3	≥5	>80	+1.+2	-	-

First day of the last menstrual period.

Family history:

Maternal medical history: DM, Hypertension, Coagulopathies.

11-Examination:

General examination:

Full general examination was done with special concern to:

- a) Vital signs: BP, Pulse, temperature, and respiratory rate.
- b) Chest and heart examination.
- c) Height, weight to calculate the BML.
- d) Lower limb examination for presence of edema.

Abdominal examination:

For assessment of the fundal height, amount of liquor, fetal lie and presentation, position of the back, fetal heart sounds, presence of uterine contractions, scar of previous surgeries.

Vaginal examination:

To assess the Bishop score of the cervix, to exclude cephalopelvic disproportion, to identify the presenting part, confirm presentation, position and detection of head station and to exclude any cause making vaginal delivery contraindicated.

Abdominal U/S

Abdominal U/S was done and by which, the following data were obtained: fetal biometry to confirm gestational age, fetal heart activity, presentation of the fetus, localization of the placenta, amount of amniotic fluid, diagnosis of multiple pregnancy, exclusion of apparent congenital anomalies with special concern to the position of the occiput, estimated fetal weight and flexion of the head whether the head is well flexed or not.

Transvaginal U/S

Trans-vaginal U/S was done for cervical length measurement.

To assess the cervical length by Trans-vaginal U/S during pregnancy we followed the following steps:

- 1-We asked the patient to empty her urinary bladder.
- 2-We slid the probe into the vagina only few centimeters and rocked the probe in the antero-posterior direction to visualize the cervix.
- 3-We visualized the line of the internal cervical canal, remembering that it is not always straight line.
- 4-We checked that the anterior and posterior lips of the cervix appear equal.
- 5-Then we slowly withdrew the probe a little and slide back to make sure there is no compression artifact.
- 6-The cervical length was measured from internal to external os.
Any funneling was recorded which is generally accepted as membrane protrusion more than 5mm down the canal.
- 7-The measurement was repeated three times and we recorded the shortest.

The ultrasound machine used was (MEDISON SONACE X-4-EXP, with abdominal probe 3.5 MHz and vaginal probe 7.5 MHz frequency).

Labor induction:

Induction of labor was done according to standard Obstetrics and Gynecology Department of Al-Hussein Hospital, Al-Azhar University guidelines for induction of labor as follows:-

(1) Prostaglandin E1 (misoprostol):

- Initial dose 50 microgram vaginal tablet (Vagiprost 25 microgram each tablet, manufactured by ADWIA CO. S.A.E Egypt).
- Full reassessment 6 hours after initial dose unless clinical condition indicates earlier assessment.

- Second dose 25 microgram in cases with unfavorable cervix.
- Reassessment 6 hours later.
- Failure of cervical ripening, the 3rd dose of misoprostol was given.
- If no cervical ripening after three doses of misoprostol, the procedure was considered a failure and the patient was delivered by caesarean section.
- If there is cervical ripening we move 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 10-15 drops/minute.
- Infusion rate was increased (by doubling drops/minute) at interval of 30 minutes, until there are three good contractions in 10 minutes, each lasting 45-60 seconds.
- 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 antepartum analgesia during the period of induction in the form of pethidine 50 mg/ 4 hourly IM.
- Deliveries were performed in the operating theater and a pediatrician and anesthetist are attending.
- All patients who delivered vaginally received active management of third stage of labor.

The fetal heart rate was considered reassuring if: ^(16,17)

- Stable baseline rate between 110 and 160 beats per minute.
- Normal short-and long-term variability (≥ 5 bpm).
- No deceleration.
- Accelerations (more than 15 beats per minute for more than 15 seconds) with fetal movement and with contractions.

On the other hand, fetal heart rate patterns were considered as non-reassuring when there are ^(16,17):

- Decreased variability (< 5 bpm for ≥ 40 min. but < 90 min.).
- Persistent mild to moderate variable decelerations.
- Occasional severe variable decelerations.
- Single prolonged deceleration up to 3 minutes.

- Moderate to severe variable decelerations in the second stage of labor.
- Fetal bradycardia (less than 110 bpm). Or fetal tachycardia > 160 bpm.

The fetal heart rate was considered as abnormal FHR pattern when there was: ^(16,17)

- Fetal heart rate <100 or > 180 sinusoidal pattern for ≥ 10 min
- Beat to beat variability <5 bpm for > 90 min.
- Atypical variable deceleration, late deceleration or single prolonged deceleration > 3 min.
- When a non-reassuring fetal heart rate was detected, closer monitoring of fetal heart rate was performed with simultaneous adequate conservative measures in the form of stoppage of oxytocin infusion, change in maternal position to the left lateral and oxygen administration.
- Uterine hyperstimulation is defined as either a series of single contractions lasting 2 minutes or more or a contraction frequency of five or more in 10 minutes (Briggs *et al.*, 2006).
- If the fetal heart rate pattern remains non-reassuring or maternal contractile abnormalities persist, prompt delivery was performed by cesarean section.

Cesarean section was done in the following situations:-

- 1- Persistent non-reassuring or abnormal fetal heart pattern.
- 2- Failed induction of labor.
- 3- Persistent contractile abnormalities.

Women's characteristics of age, gestational age and initial Bishop score were recorded.

The primary outcome was successful attempt for vaginal delivery.

The secondary outcomes were induction to delivery interval (**IDI**) and Apgar score of the newborn at 1 and 5 minutes.

Using the definition of **Ness *et al.*** ⁽¹⁸⁾, an induction attempt was considered successful if the patient reached the active phase of labor as demonstrated by progressive dilatation and effacement of the cervix and followed by vaginal delivery.

All women's data were recorded in a special input form.

Data management and statistical analysis:

Gathered data were processed using suitable statistical package.

Quantitative data were expressed as means – or + SD while qualitative data were expressed as numbers and percentages (%).

Student- t –test was used to test significance of difference for quantitative variables and Chi Square was used to test significance of difference for qualitative variables.

A probability value (p-value) ≤ 0.05 is considered statistically significant.

Other statistical tools were used when appropriate and applicable.

Data were analyzed and appropriately in tables and figures.

RESULTS

Table 2: distribution of the study population as regards parity and gestational ages

	Description (n= 100)	
	N	%
Parity		
Primi-para	50	50.0
Multi-para	50	50.0
Gestational age		
37 th week	14	14.0
38 th week	24	24.0
39 th week	26	26.0
40 th week	17	17.0
41 th week	16	16.0
42 th week	3	3.0

The clinical criteria of patients included in this study were shown in **table 3**. Their maternal age ranged from 15- 35 years, gestational ages ranged from 37- 42 weeks, misoprostol (vagiprost) doses used in this study ranged from 25 -100 mg, Bishop score for patients included in this study ranged from 3 - 9, Cervical length (mm) measured by TVUS ranged from 13- 42 mm and posterior cervical angle measured by TVUS ranged from 70 -140.

Table 3: demographic and clinical characteristics of patients of the studied population

Variable	Range	Mean \pm SD
Maternal age	18 – 35	27.1 \pm 4.4
Gestational age	37 – 42	39.1 \pm 1.4
Cervical length (mm)	13 – 42	27.0 \pm 7.1
Bishop score	3 – 9	6.0 \pm 2.0
Posterior cervical angle	70 – 140	105.5 \pm 18.7
Vagiprost dose	25 – 100	68 \pm 29.5

All patients underwent induction received misoprostol (vagiprost) tablets as a method of cervical ripening ranged from 25-100 mg but only 56.0% of them augmented by oxytocin as shown in **table 4**.

Table 4: pharmacological agents used for labor induction

		Description (n= 100)	
		N	%
Vagiprost dose	1 tablet 25 mg	21	21.0
	2 tablets 50 mg	24	24.0
	3 tablets 75 mg	17	17.0
	4 tablets 100 mg	38	38.0
Augmented with oxytocin	Yes	56	56.0
	No	44	44.0

The most common causes of induction in this study were due to PIH (34%), postdate (31%), IUGR (20%) and DM (15%) respectively and vaginal deliveries occurred in 56 (56.0%) of patients and CS deliveries occurred in 44 (44.0%) due to failed induction 47.7%, fetal distress 29.5% and cervical dystocia 22.7% as shown in **table 5**.

Table 5: causes of labor induction and delivery mode and causes of CS in this study

	Description (n= 100)	
	N	%
Causes of induction		
PIH	34	34.0
DM	15	15.0
Postdate	31	31.0
IUGR	20	20.0
Delivery mode		
Vaginal	56	56.0
Cesarean section	44	44.0
Indications of Cesarean section		
Failed induction	21	47.7
Fetal distress	13	29.5
Cervical dystocia	10	22.7

There was highly statistically significant relations (**HS**) detected between mode of delivery and cervical length, bishop score and posterior cervical angle as p value (**0.001**). It was

found that the more obtuse the angle, the higher the probability of vaginal delivery and the reverse for the cervical length. This means that Bishop Score and cervical length and posterior cervical angle have the same dependency in predicting successful labor induction as shown in **table 6**.

Table 6: comparison between cervical length, Bishop Score and posterior cervical angle as regards mode of delivery

	Vaginal delivery (n= 56)	Cesarean section (n=44)	P value
Cervical length (mm)	23.4 ± 4.6	31.6 ± 7.2	<0.001 HS
Bishop score	7.5 ± 1.0	4.1 ± 1.0	<0.001 HS
Posterior cervical angle	119.1 ± 12.7	88.1 ± 6.9	<0.001 HS

In our study, we found highly statistically significant relations (**HS**) between mode of delivery with induction time and dose of misoprostol (vagiprost) as (**p value <0.001**) and only significant relation (**S**) with fetal weight as (**p value 0.04**) and non significant relation (**NS**) with gestational age as (**p value 0.9**) as shown in **table 7**.

Table 7: relations between delivery mode and other parameters

	Vaginal delivery (n= 56)	Cesarean section (n=44)	P value
Gestational age	39.07 ± 1.39	39.05 ± 1.38	0.9 NS
Induction time	12.8 ± 5.5	20.6 ± 4.5	<0.001 HS
Vagiprost dose	52.2 ± 27.5	88.1 ± 17.5	<0.001 HS
Fetal weight (Kg)	3.11 ± 0.40	3.28 ± 0.37	0.04 S

Table 8 showed highly statistical significant relations (**HS**) between mode of delivery with parity and augmentation with oxytocin and non significant relation (**NS**) between mode of delivery and causes of induction.

Table 8: relations between delivery mode with parity and causes of labor induction

	Vaginal delivery (n= 56)		Cesarean section (n=44)		P value
	N	%	N	%	
Parity					
Primi-para	18	32.1	32	72.7	<0.001
Multi-para	38	67.9	12	27.3	HS
Oxytocin					
Received	56	100.0	0	0.0	<0.001
Don't receive	0	0.0	44	100.0	HS
Causes of labor induction					
PIH	17	30.4	17	38.6	0.7
DM	8	14.3	7	15.9	NS
Postdate	20	35.7	11	25.0	
IUGR	11	19.6	9	20.5	

Table 9 showed highly statistical significant relation (**HS**) between parity and augmentation with oxytocin.

Table 9: relation between augmentation with oxytocin and parity

	Oxytocin				P value
	Received		Don't receive		
	N	%	N	%	
Parity					
Primi-para	18	32.1	32	72.7	<0.001
Multi-para	38	67.9	12	27.3	HS

Table 10 showed highly significant positive correlation detected between induction time and cervical length as **p value (0.001)** and (**r = 0.706**) and highly significant negative correlation between induction time and bishop score and posterior cervical angle.

Table 10: correlation between induction time with Cx length, Cx angle and Bishop score

		Induction time
Cervical length (mm)	r*	0.706
	P value	<0.001
Bishop score	r*	-0.700
	P value	<0.001
Posterior cervical angle	r*	-0.631
	P value	<0.001

*Correlation coefficient

Table 11 showed significant (**s**) relation detected between parity and dose of misoprostol (vagiprost) needed for induction.

Table 11: comparison of Vagiprost dose as regards parity

	Primi-para	Multi-para	P value
Vagiprost dose	75.5 ± 26.0	60.5 ± 31.2	0.01

Table 12 showed insignificant relation (**NS**) was detected between parity and causes of induction and significant relation (**S**) was detected between parity and indications of cesarean section.

Table 12: comparison of causes of induction and CS indications as regards parity

		Primi-para		Multi-para		P value
		N	%	N	%	
Causes of induction	PIH	22	44.0	12	24.0	0.2
	DM	6	12.0	9	18.0	NS
	Postdate	12	24.0	19	38.0	
	IUGR	10	20.0	10	20.0	
Indications of Cesarean section (n=44)	Failed induction	18	56.3	3	25.0	0.03
	Fetal distress	10	31.3	3	25.0	S
	Cervical dystocia	4	12.5	6	50.0	

Table 13 showed that there was highly statistical significant positive correlation (**HS**) detected between vagiprost dose with cervical length and induction time. And highly statistical significant negative correlation (**HS**) detected between vagiprost dose with bishop score and posterior cervical angle.

Table 13: correlation between Vagiprost dose with Cx length, Cx angle, Bishop score and induction time

		Vagiprost dose
Cervical length (mm)	R	0.661
	P value	<0.001
Bishop score	R	-0.720
	P value	<0.001
Posterior cervical angle	R	-0.630
	P value	<0.001
Induction time	R	0.957
	P value	<0.001

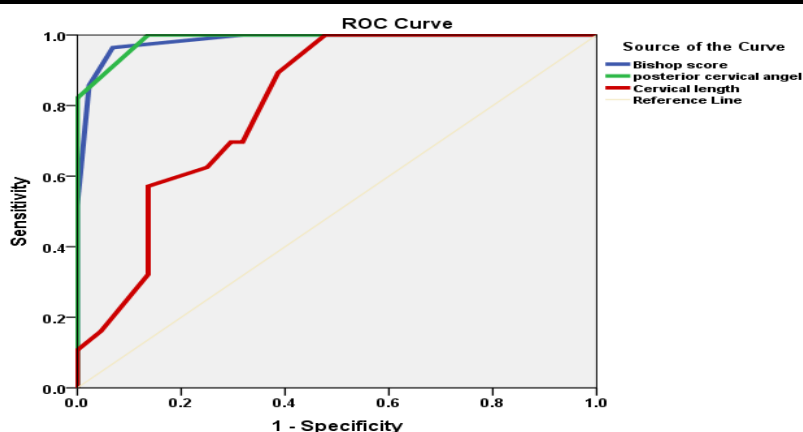


Figure 1: ROC curve analysis to determine the discriminant ability of Bishop score, posterior cervical angle & cervical length to predict induction success

ROC curve of Bishop score showed that Area under the curve (AUC) =0.984, p value <0.001, 95% CI (0.965-1.00). (ROC) curve of posterior cervical angle showed that Area under the curve (AUC) =0.988, p value <0.001, 95% CI (0.974-1.00). (ROC) curve of cervical length showed that area under the curve (AUC) =0.805, p value <0.001, 95% CI (0.714- 0.896) as shown in **table 16**.

Table 14: AUC of Bishop score, posterior cervical angle and cervical length and CI in the prediction of successful induction of labor

	AUC	95% CI of AUC	P value
Posterior cervical angle	0.988	0.974 – 1.00	<0.001
Bishop score	0.984	0.965 – 1.00	<0.001
Cervical length	0.805	0.714 – 0.896	<0.001

AUC= area under the curve, CI= confidence interval

Table 15 showed that Bishop score ≥ 6 (which was the cutoff point) had a sensitivity of 96.4%, specificity of 93.2%, positive predictivity (PPV) of 94.7%, negative predictivity (NPV) of 95.3% and its accuracy 95.0% in predicting successful labor induction. Posterior cervical angle $\geq 95^\circ$ (which was the cutoff point) had a sensitivity of 100%, specificity of 86.4%,

positive predictivity (PPV) of 90.3%, negative predictivity (NPV) of 100% and accuracy 94.0% in predicting successful labor induction. Cervical length $\leq 29\text{mm}$ (which was the cutoff point) had a sensitivity of 89.3%, specificity of 61.4%, positive predictivity (PPV) of 74.6%, negative predictivity (NPV) of 81.8% and accuracy 77.0% in the prediction of successful labor induction.

Table 15: validity of cervical length, posterior cervical angle and Bishop score in the prediction of successful induction of labor

	Cut-off point	Sensitivity	Specificity	PPV	NPV	Accuracy
Post. Cx. Angle	≥ 95	100.0%	86.4%	90.3%	100.0%	94.0%
Bishop score	≥ 6	96.4%	93.2%	94.7%	95.3%	95.0%
Cervical length	≤ 29	89.3%	61.4%	74.6%	81.8%	77.0%

NB: regression analysis couldn't be performed as all of angle, length & Bishop Score are highly correlated so they remove the effect of each other so the regression analysis will be useless & reveal error numbers so we can use the ROC curve analysis only to detect the discriminant ability of each predictor

DISCUSSION

Induction of labor represents one of the most common interventions in clinical obstetrics which have been estimated to account for up to 25% of term pregnancies. Induction of labor is an intervention to artificially initiate uterine contraction leading to progressive dilatation and effacement of the cervix and birth of baby⁽¹⁰⁾. Labor induction, whether medically indicated or elective, is associated with an increased risk of cesarean delivery, particularly in nulliparous women and women with an unfavorable cervix⁽¹⁹⁾. 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 low Bishop score⁽¹⁰⁾. As the supra-vaginal portion of the cervix makes up about 50% of the cervical length and varies from one woman to another. This portion of the cervix is difficult to estimate digitally and it makes assessment highly subjective⁽²⁰⁾. Therefore, a reliable and well-tolerated method of pre-induction assessment would be a helpful tool in the assessment and counseling of women planned for labor induction⁽²¹⁾. Transvaginal sonography (TVS) for cervical length and posterior cervical angle measurements has been suggested as a more tolerated and objective method than digital examination by Bishop Score in assessing the success of labor induction⁽²²⁾. However, it has also been suggested that transvaginal ultrasonographic measurement of cervical length does not add any additional benefit to the prediction of cervical inducibility obtained by the Bishop score⁽²³⁾. In this study, there was nearly the same highly statistical significant correlation between the transvaginal ultrasonographic measurements of cervical length, posterior cervical angle and Bishop score with mode of delivery and successful labor

induction. This agreed with results of **Yang *et al.***⁽²³⁾ who studied induction of labor in 105 women. The most common reason for induction was post term pregnancy of 41 completed weeks or more followed by a large for gestational age fetus. And they found that successful induction correlated significantly with parity, the Bishop Score and ultrasonographic cervical measurements. Maternal age and gestational age were not significant predictive factors.

In our study 56 patients were delivered vaginally 54 of them had Bishop score ≥6 and the rest were expected to deliver by CS as they had Bishop score <6, but they delivered vaginally on the contrast of our expectancy in the study. And so we found that Bishop score ≥6 had a sensitivity of 96.4%, specificity of 93.2%, positive predictivity (PPV) of 94.7%, negative predictivity (NPV) of 95.3% and diagnostic accuracy 95.0% in the prediction of successful labor induction. Receiver operating characteristic (ROC) curve of Bishop score shows that Bishop score ≥6 is the cut off point for prediction of successful labor induction showed an Area under the curve (AUC) =0.984, p value <0.001, 95% CI (0.965-1.00). In agreement with our results, **Rozenberg *et al.***⁽²²⁾ found in their study of 166 women induced with prostaglandins found the Bishop score to be better than cervical length for predicting successful outcome of induced labor.

In our study, the 56 patients that delivered vaginally all of them had posterior cervical angle ≥95° and the 44 patients that delivered by CS 6 of them we were expecting to deliver vaginally as they had angles ≥95° and on the contrast to our expectancy they delivered by CS. So we found that Posterior cervical angle >95° had a sensitivity of 100%, specificity of 86.4%, positive predictivity (PPV) of 90.3%, negative predictivity (NPV) of 100% and diagnostic accuracy 94.0% in the prediction of successful labor induction. Receiver operating characteristic (ROC) curve of posterior cervical angle shows that posterior cervical angle ≥95° is

the cut off point for prediction of successful labor induction showed an Area under the curve (AUC) =0.988, p value <0.001, 95%CI (0.974-1.00). In agreement with our study, **Paterson-Brown et al.** ⁽²⁴⁾ compared the accuracy of transvaginal sonographic evaluation of the cervix with the Bishop score.

They studied the ultrasound measurement of the cervical dilatation, length, thickness of the lower uterine segment, application of the fetal head and posterior cervical angle and reported that posterior cervical angle was more accurate in the prediction of vaginal delivery than Bishop score. Combining posterior cervical angle of more than 70 with Bishop score greater than 5 yielded the best accuracy in the prediction of successful vaginal delivery ⁽¹⁰⁾. But, results of **Keepanasseril et al.** ⁽¹³⁾ are not in agreement with results of our study since they found that transvaginal sonographic assessment of posterior cervical angle is better than conventional Bishop score in predicting successful labor induction.

In another study **Eggebo et al.** ⁽²⁵⁾ found that the posterior cervical angle measured by TVS was more accurate than Bishop Score in predicting the successful vaginal delivery. In our study the 56 patients who delivered vaginally 6 of them we were expecting to deliver by CS as they had cervical length > 29mm but on the reverse of our expectancy they delivered vaginally.

In the study we found that cervical length \leq 29mm had a sensitivity of 89.3%, specificity of 61.4%, positive predictivity (PPV) of 74.6%, negative predictivity (NPV) of 81.8% and diagnostic accuracy 77.0% in the prediction of successful labor induction. Receiver operating characteristic (ROC) curve of cervical length \leq 29mm for prediction of successful labor induction showed an Area under the curve (AUC) =0.805, p value <0.001, 95%CI (0.714-0.896).

In agreement with our study, **Roman et al.** ⁽²⁶⁾ found in their study that consisted of 106 cases that cervical length was not better than Bishop Score as an indicator in determining delivery mode.

Also, **Rozenberg et al.** ⁽²²⁾ compared digital and ultrasound examination of the cervix in predicting time interval from induction to delivery and vaginal delivery in 266 women; they concluded that ultrasonographic cervical length measurement is not a good predictor in comparison to Bishop Score.

Paterson-Brown et al. ⁽²⁴⁾ compared ultrasound data to the mode of delivery and

reported that cervical length was not predictive of the mode of delivery. Although Bishop Score correlated significantly with successful vaginal delivery. **Rane et al.** ⁽⁶⁾ in their study observed that sonographic posterior cervical angle was significant in predicting successful outcome of induction of labor.

It was found that for a specificity of 75%, the sensitivity of ultrasound findings was 89% and for Bishop score was 65% only.

Tan et al. ⁽¹⁴⁾ found that Bishop Score, since its description in 1964, remains the gold standard for assessing favorability for induction of labor. Transvaginal ultrasonography has been shown by number of studies to be a better predictor of cesarean section than Bishop score, but this finding has been not reported consistently.

A recent meta-analysis concluded that transvaginal sonography has not been shown to be superior to Bishop score and needs further research. Previous studies with limited number of women have indicated that transvaginal sonography is less painful than digital examination by Bishop Score. In this study we found that the validity of cervical length, posterior cervical angle and Bishop Score as predictors of successful labor induction indicates that posterior cervical angle was the most sensitive predictor of successful labor induction then Bishop score and the last is cervical length. But Bishop score showed more specificity, positive predictive value and diagnostic accuracy (93.2%, 94.7%, 95.0% respectively) for the prediction of successful labor induction.

Also, according to this study, we found that combining trans vaginal ultrasonographic measurements of posterior cervical angle of more than 95, cervical length less than 29mm with Bishop score greater than 6 had the best accuracy in the prediction of successful vaginal delivery.

The regression analysis of ROC could not be performed as all of angle, length and Bishop score are highly correlated with prediction of successful labor induction as (**p value<0.001**), so they had the same dependency as Bishop score in predicting successful labor induction, so they remove the effect of each other and the regression analysis will be useless, we can use the ROC curve analysis only to detect the discriminant ability of each predictor.

CONCLUSION

1- In this study we found that successful induction correlated significantly with transvaginal ultrasonographic measurements

of posterior cervical angle and cervical length and Bishop score. But Bishop score appeared to be specific and accurate than ultrasonographic measurements in prediction of successful vaginal delivery.

- 2- Both transvaginal sonographic measurement of cervical length and posterior cervical angle and Bishop score are useful and have the same dependency as predictors of successful labor induction.
- 3- Transvaginal sonographic measurement of cervical length and posterior cervical angle is better tolerated by the patient than digital examination for Bishop Score assessment.
- 4- In our prospective study, we found that values of 2D ultrasound and 3D ultrasound in measuring cervical length and posterior cervical angle were the same results. So we did the comparison between 2D ultrasound and digital assessment of cervix (Bishop Score) before induction of labour.

RECOMMENDATIONS

Transvaginal ultrasonographic measurements of the cervical length and posterior cervical angle add an additional benefit but cannot replace Bishop score in the prediction of cervical inducibility. As we found that the posterior cervical angle was a sensitive predictor.

But Bishop Score was found to be the most specific and accurate predictor in the prediction of successful labor induction.

So further studies on large number of participant with the same indication of induction and the same gestational age are recommended to assess Bishop Score and transvaginal ultrasonographic measurements and evaluate each of them as predictors of successful labor induction.

REFERENCES

1. **American College of Obstetricians and Gynecologists (ACOG) (2003):** Dystocia and augmentation of labor. ACOG Practice Bulletin, 24: 538-541.
2. **Ayers S, Collenette A, Hollis B and Manyonda I (2005):** Feasibility study of a latest date of delivery (LDD) system of managing pregnancy. Psychosomatic Obstet. Gynaecol., 26(3):167-171.
- 1- **Delaney M, Roggensack A, Leduc DC, Ballermann C, Bi-ringer A et al. (2008):** Guidelines for the management of pregnancy at 41+0 to 42+0 weeks. JOGC., 214:800-808.
- 2- **Norwitz ER, Snegovskikh VV and Caughey AB (2007):** Prolonged pregnancy: when should we intervene. Clin Obstet. Gynecol., 50(2):547-557.
- 3- **Galal M, Symonds I, Murray H, Petraglia F and Smith R (2012):** Postterm pregnancy. Facts Views Vis. Obgyn., 4(3): 175-187.
- 4- **Rane SM, Pandis GK, Guirgis RR, Higgins B and Nicolaides KH (2003):** Preinduction sonographic measurement of cervical length in prolonged pregnancy: the effect of parity in the prediction of induction to-delivery interval. Ultrasound Obstet. Gynecol., 22(1):40-44.
- 5- **Eggebo TM, Heien C, Økland I, Gjessing LK, Romundstad P and Salvesen KÅ (2008):** Ultrasound assessment of fetal head-perineum distance before induction of labor. Ultrasound in Obstetrics and Gynecology, 32(2):199-204.
- 6- **Anish, Vanita S and Rashmi B et al. (2007):** Pre-induction sonographic assessment of the cervix in the prediction of successful induction of labor in nulliparous women. Australian and New Zealand Journal of Obstetrics and Gynaecology, 47:389-393.
- 7- **Groeneveld Y, Bohnenb A and Van heusden A (2010):** Cervical length measured by transvaginal ultrasonography versus Bishop score to predict successful labor induction in term pregnancies. Gyn., 2 (3): 187-193.
- 8- **Selhi M and Surapaneni T (2010):** Pre induction sonographic measurement of cervical length: An adjunct to Bishop Score? Fernandez Hospital Journal of Perinatology, 247:381-390.
- 9- **Kolkman DG, Verhoeven CJ, Brinkhorst SJ, van der Post JA, Pajkrt E, Opmeer BC and Mol BW (2013):** The Bishop score as a predictor of labor induction success: a systematic review. American Journal of Perinatology, 30(08):625-630.
- 10- **Rane SM, Guirgis RR, Higgins B and Nicolaides KH (2004):** The value of ultrasound in the prediction of successful induction of labor. Ultrasound Obstet. Gynecol., 24: 538-549.
- 11- **Keepanasseril A, Suri V, Bagga A and Aggarwal Y (2007):** Pre-induction sonographic assessment of the cervix in the prediction of successful induction of labor in nulliparous women. Australian and New Zealand Journal of Obstet. and Gynecol., 47(5): 393-389.
- 12- **14) Tan PC, Vallikkannu N, Suguna S, Quek KF and Hassan J (2007):** Transvaginal sonographic measurement of cervical length vs. Bishop score in labor induction at term: tolerability and prediction of cesarean delivery. Ultrasound Obstet. Gynecol., 29: 568-573
- 13- **15) Gulmezoglu AM, Crowther CA and Middleton P (2006):** Induction of labor for improving birth outcomes for women at or beyond term. Cochrane Database Syst. Rev., 4: 4945-4955.
- 14- **NICE (2007):** Induction of labor, Clinical Guideline , 29: 560-57.
- 15- **RCOG (2001):** Induction of labor. Evidence Based Clinical Guideline, 9:800-808.
- 16- **Ness A, Goldberg J and Berghella V (2005):** Abnormalities of the first and second stages of labor. Obstetrics and Gynecology Clinics of North America, 32(2):201-220.
- 17- **Ann S H, Luis S and Andrew M (2007):** Sonographic cervical assessment to predict the success of labor induction: a systematic review with

- meta analysis. *Am. J. Obstet. Gynecol.*, 186:192-200.
- 18- Bouyer J, Papiernik E, Dreyfus J, Collins D, Wnini doerffer B and Gueguen S (1986):** Maturation signs of the cervix and prediction of preterm birth. *Obstetrics and Gynecology*, 68:209 – 214
- 19- Park KH (2007):** Transvaginal ultrasonographic cervical measurement in predicting failed labor induction and cesarean delivery for failure to progress in Nulliparous women. *J. Korean Med Sci.*, 22: 722-727.
- 20- Rozenberg P, Chevret S and Chastang C (2005):** Comparison of digital and ultrasonographic examination of the cervix in predicting time interval from induction to delivery in women with a low Bishop score. *BJOG.*, 112:192-198.
- 21- Yang S, Roh C and Kim J (2004):** Transvaginal ultrasonography for cervical assessment before induction of labor. *Management of Labor, Delivery and Puerperium*, 59 (8): 577-579.
- 22- Paterson-Brown S, Fisk NM, Edmonds DK and Rodeck CH (1991):** Preinduction cervical assessment by Bishop's score and transvaginal ultrasound. *Eur. J. Obstet. Gynecol. Reprod. Biol.*, 40: 17-23.
- 23- Eggebø T, Økland I, Heien C, Gjessing L, Romundstad P and Salvesen K (2009):** Can ultrasound measurements replace digitally assessed elements of the Bishop score? *Acta Obstetrica et Gynecologica Scandinavica*, 88(3): 325–331.
- 24- Roman H, Verspyck E and Vercoustre I (2004):** Does ultrasound examination when the cervix is unfavorable improve the prediction of failed labor induction? *Ultrasound Obstet. Gynecol.*, 23:357-362.