The Distance from Maternal Perineum to Fetal Head as a Predictive of Successful Induction of Labor

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Abstract: Aim of the study: The aim of this study is to evaluate the ultrasound measurements of the fetal head perineum distance measured by transperineal ultrasound and cervical length measured by transvaginal ultrasound imaging as a predictive factors for successful IOL and to creat a cut-off level of these parameters which may be helpful in predicting successful induction of labour. **In the current study** a prospective observational study was carried out on 180 pregnant women attending casualties of Ain Shams University Maternity Hospital during the period from march 2011 to December 2011.All patients underwent cervical assessment including cervical dilatation (cm), cervical effacement (%), station of presenting part, cervical consistency and position (using modified Bishop score system) All participants in this study were subjected to transperineal U/S for assessment of fetal head station and transvaginal U/S for assessment of cervical length and width. **Conclusion and Recommendations:** Fetal head–perineum distance measured by transperineal ultrasound examination can predict vaginal delivery after induction of labor, with a predictive value similar to that of ultrasonographically measured cervical length and the Bishop score. Also, this technique helps in converting the labor into numerical figure (digitalization of labor). However, we judge none of these methods used alone to be good enough in a clinical setting. So, the cut off level of ultrasound measurements and clinical assessments together may become useful. The cut off level of head perineal distance is 4 cm below which the induction of labor is favorable, while the cut of level of cervical length is 2.5cm below which the induction of labor is favorable. These parameters in association with digitally assessed cervical dilatation is recommended to discriminate successful and failed induction of labor.

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1. Introduction

Induction of labor is an increasingly common obstetric intervention. The current induction rate in developed countries is 13-20% ***(MacDorman et al., 2002).***

The procedure is associated with increased risk of cesarean delivery ***(Heffner et al., 2003).***

Timing of induction for indications such as diabetes, post-term pregnancy and preeclampsia is debated, and many women ask for induction without medical indications.

Objective methods for assessment of the cervix and fetal head descent would be useful when counseling women prior to induction.

Maternal characteristics, Bishop score, and ultrasound measurements used alone have limitations, and combinations of factors have been suggested ***(Rane et al., 2004, Bueno et al., 2005).***

In some studies, transvaginal ultrasound measurements of cervical length seemed better than the Bishop score in predicting outcome of induction ***(Pandis et al., 2001,Rane et al., 2004; Laencina et al., 2007),*** but not in others ***(Rozenberg et al., 2005).***

Ultrasound measured posterior cervical angle ***(Rane et al., 2004)*** and fetal head engagement have also been found to predict labor outcome ***(Dietz et al., 2006; Eggebø et al., 2006)***.

A recent meta-analysis called for more research in this field ***(Crane et al., 2006).***

If a successful labor outcome could be predicted, IOL could be considered in cases with 'soft indications' or on maternal request. Thus, any reliable methods of preinduction assessment would be valuable tools in counseling women before IOL ***(Eggebo et al., 2008).***

Ultrasound measurements of the fetal head-perineum distance has not been evaluated as a predictive factor in women scheduled for IOL, but it was found to predict labor outcome for women with prelabor rupture of membranes at term ***(Eggebo et al., 2006).***

So, ultrasound measurements of the fetal head-perineum distance and cervical length will be used as predictors of successful induction of labor.

2. Patients and Methods

The study was carried out at Ain Shams University Maternity Hospital. A total of 180 women will be subjected to our study.

Inclusion criteria for this study are:

1. Maternal age ranges from 18-38 years.
2. Gestational ages range from 37-42 weeks according to a mid-trimester scan ,or reliable last menstrual period.
3. A live singleton pregnancy with cephalic presentation.
4. Giving a written consent before inclusion in this study
5. Indication for induction of labour as:

- Postdate, intrauterine Growth Restriction (IUGR), pregnancy Induced Hypertension (PIH), Diabetes Mellitus (DM), and Prelabor Rupture Of Membranes (PROM).

Exclusion criteria for this study are:

1. In labor.
2. Previous CS or any scar in uterus.
3. Presence of obstetric causes interfering with induction of labor, placenta previa, major fetal anomaly and patient whose gestational age was uncertain.

All women after consenting were subjected to the followings:

1. Medical history:

Including personal history (name, age, occupation, residence and special habits), obstetric history (parity, first day of last menstrual period and history of contraceptive method), past history (history of DM, hypertensive disorders and cardiac disorders), past history of laparotomies or other operations and history of the present pregnancy.

2. General examination:

Including assessment of vital data (blood pressure, pulse, respiratory rate and temperature).

3. Abdominal examination:

Including fundal level, fundal grip, umbilical grip, first pelvic grip, second pelvic grip, fetal heart rate and presence of scar of previous operations.

4. Local vaginal examination:

Including pelvic capacity, the presenting part (cephalic presentation) and presence of intact or rupture membranes.

5. Bishop score:

Cervical assessment including cervical dilatation (cm), cervical length, station of presenting part, cervical consistency and position (using modified Bishop score system) ***(Bishop, 1964)*** (Table 1)

Table (1): Modified Bishop Score

Point value	0	1	2	3
Dilatation (cm)	Closed	1-2	3-4	5 or more
Cervical length	3 cm	2cm	1cm	0
Station	-3	-2	-1 or 0	+1 or +2
Consistency	Firm	medium	soft	
Cervical position	posterior	Middle	anterior	

Ultrasound assessment in this study:

All participants in this study were subjected to transperineal U/S for assessment of fetal head station and transvaginal U/S for assessment of cervical length using Medison x6, x4, or Mindreah 6900 machines with a 3.5_7.5 mHz multifrequency transabdominal transducer and a 5.0_9.0 mHz multifrequency transvaginal transducer as described by ***Valentin and Bergelin (2002)*** who stated that the women were examined in the lithotomy position. The ultrasound probe was slowly advanced into the vagina until the cervix was clearly seen, care being taken not to apply pressure with the probe on the cervix. Neither fundal nor suprapubic pressure was applied. The presence of an open inner cervical os was noted. Cervical length and width were measured on images showing the full length of the cervix with a clearly visible inner and outer cervical os ***(Valentin and Bergelin, 2002).***

The fetal head perineal distance was measured as the shortest distance from the outer bony limit of fetal skull to the skin surface of the perineum by the transperineal ultrasound examination in transverse view with the probe held over the ischial tuberosity with firm pressure, but without creating any discomfort for the women and the transducer was moved and angled until the shortest distance to the fetal head is visualized as described by ***Eggebo (2008)***.

Induction of labor:

Induction of labor was performed according to management protocol of Ain Shams Maternital Hospitals, Labor was induced with amniotomy followed by oxytocin if the cervix was favorable (Bishop score 6 or more).If the cervix was unfavorable (Bishop Score less than 6), labor was induced with 25 microgram misoprostol applied vaginally every four hours (maximum 100 microgram in 24 hours and a total maximum dose of 200 microgram) until regular contractions. Cesarean section was performed if a woman had an unfavorable cervix after having received the maximum misoprostol dose.

Successful IOL was resulting in a vaginal delivery, either spontaneous or operative, in 24 hours of start of induction. During observation of the patients, the total doses received, complications and total duration were recorded, intrapartum fetal surveillance was done according to local protocol of Ain Shams Maternity Hospitals.

3. Results

The mean age of included women was 26.54 ± 6.24 years (range: 18 – 38 years). The median parity was 1 (range: 0 – 5; interquartile range: 0 – 2). Of the included 180 women, 66 (36.7%) were primiparous, while 114 (63.3%) were parous. The mean gestational age was 39.16 ± 1.51 weeks (range: 36 – 43 weeks)

Of the included 180 women, 99 (55%) underwent induction of labor for pre-labor rupture of membranes (PROM), 48 (26.7%) for post-date, while 33 (18.3%) for medical disorders with pregnancy. Of the included 180 women, 19 (10.6%) had a modified bishop score of 3, 48 (26.7%) had a score of 4, 51 (28.3%) had a score of 5, 46 (25.6%) had a score of 6, while 16 (8.9%) had a score of 7. The mean sonographic cervical length [measured by transvaginal scan (TVS)] was 2.03 ± 0.59 cm (range: 1 – 4 cm). Of the included 180 women, 117 (65%) had a sonographic cervical length ≤ 2 cm, 152 (84.4%) had it **> 2 – ≤ 2.5 cm** while 174 (96.7%) had it **> 2.5 – ≤ 3 cm**. The mean sonographic cervical width was 2.23 ± 0.85 cm (range: 0.5 – 4 cm) .

The mean sonographic head-perineum distance (HPD) [measured by transperineal sonography] was 4.4 ± 0.72 cm (range: 3 – 6 cm). Of the included 180 women, 63 (35%) had a sonographic HPD ≤ 4 cm, 109 (60.6%) had it **> 4 – ≤ 6.5 cm**, while 145 (80.6%) had it **≥ 7 cm** .

The mean sonographic estimated fetal weight (EFW) was 3.33 ± 0.3 Kg (range: 2.8 – 3.9 Kg) .

Of the included 180 women, 62 (34.4%) received intravenous oxytocin infusion as the method of induction of labor, while 118 (65.5%) received vaginal misoprostol; of them, 9 (7.6%) received 1 dose, 44 (37.3%) received 2 doses, 57 (48.3%) received 3 doses, while 8 (6.8%) received 4 doses. The mean onset-to-active phase interval was 9.53 ± 3.43 hours (range: 2 – 16 hours). The mean duration of the active phase was 4.15 ± 1.31 hours (range: 0 – 6 hours). Of the included 180 women, 133 (73.9%) delivered vaginally, while 47 (26.1%) delivered by Cesarean section (CS); of them, 26 (55.3%) underwent CS due to failed induction of labor, 12 (25.5%) were due to secondary arrest of cervical dilatation, while 9 (19.2%) were due to fetal distress .

The mean birth weight was 3.36 ± 0.33 Kg (range: 2.3 – 3.8 Kg). Of the neonates of the included 180 women, 94 (52.2%) were males, while 86 (47.8%) were females. The median 1-min Apgar score was 6 (range: 5 – 9; interquartile range: 6 – 7). The median 5-min Apgar score was 9 (range: 7 – 9; interquartile range: 8 – 7). Of the included 180 neonates, 7 (3.9%) needed neonatal resuscitation, and 3 (1.7%) needed NICU admission

There was a significant positive correlation between digital and sonographic cervical length in included women, whether in general [r_s=0.525, p<0.001] or when split into primiparous [r_s=0.500, p<0.001] and parous women [r_s=0.562, p<0.001] .

There was a significant positive correlation between digital cervical dilatation and sonographic cervical width in included women, whether in general [r_s=0.561, p<0.001] or when split into primiparous [r_s=0.666, p <0.001] and parous women [r_s=0.525, p <0.001] .

There was a significant negative correlation between station of the head and sonographic HPD in included women, whether in general [r_s=-0.528, p <0.001] or when split into primiparous [r_s=-0.502, p <0.001] and parous [r_s=-0.549, p <0.001] . Receiver operator characteristics (ROC) curves were constructed for the modified Bishop score, sonographic cervical length, sonographic cervical width and HPD as predictors of successful vaginal delivery among all included women (Figure-1). All these variables were significant predictors, with the modified Bishop score and HPD being the most significant, having the largest areas under curve (AUC) [0.893, 95% CI (0.840 to 0.947), p<0.001 and 0.893, 95% CI (0.840 to 0.946), p<0.001, respectively] .

The results of the current study showed that among all included women, an initial Bishop score of ≥ 5 was a significant predictor of successful vaginal delivery [at a sensitivity of 78.2%, positive predictive value (PPV) of 93.7%, negative predictive value (NPV) of 51.7%, false positive rate (FP) of 18.4% and a positive likelihood ratio (LR+) of 4.2].

Among all included women, an initial sonographic cervical length ≤ 2.15 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 80.5%, PPV of 91.5%, NPV of 51.9%, FP of 26.3% and a LR+ of 3.1].

Among all included women, an initial sonographic cervical width ≥ 1.9 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 81.2%, PPV of 91.5%, NPV of 52.8%, FP of 26.3% and a LR+ of 3.1].

Among all included women, an initial HPD ≤ 4.85 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 84.2%, PPV of 94.9%, NPV of 60.4%, FP of 15.8% and a LR+ of 5.3] .

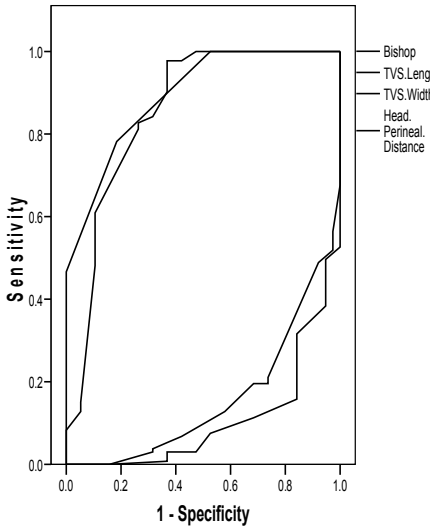

Fig. (1): ROC Curve for Modified Bishop Score as Predictor of Successful Vaginal Delivery in All Included Women.

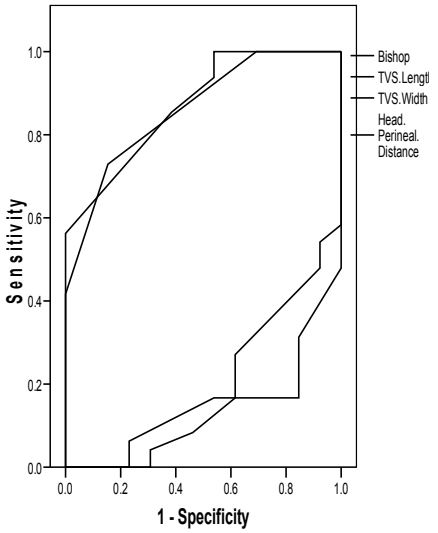

Fig. (2): ROC Curve for Modified Bishop Score as Predictor of Successful Vaginal Delivery in Primiparous Women.

ROC curves were constructed for the modified Bishop score, sonographic cervical length, sonographic cervical width and HPD as predictors of successful vaginal delivery among primiparous women(Figure-2).. All these variables were significant predictors, with the sonographic cervical width and modified Bishop Score being the most significant, having the largest areas under curve (AUC) [0.872, 95% CI (0.776 to 0.968), p<0.001 and 0.861, 95% CI (0.760 to 0.963), p<0.001, respectively] .

The results of the current study showed that among primiparous women, an initial Bishop score of ≥ 5 was a significant predictor of successful vaginal delivery [at a sensitivity of 72.9%, PPV of 94.6%, NPV of 45.8%, FP of 15.4% and a LR+ of 4.7] .

Among primiparous women, an initial sonographic cervical length ≤ 2.4 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 83.3%, PPV of 88.9%, NPV of 50%, FP of 38.5% and a LR+ of 2.2].

Among primiparous women, an initial sonographic cervical width ≥ 1.8 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 85.4%, PPV of 89.1%, NPV of 53.3%, FP of 38.5% and a LR+ of 2.2] .

Among primiparous women, an initial HPD ≤ 4.8 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 83.3%, PPV of 95.2%, NPV of 57.9%, FP of 15.4% and a LR+ of 5.4].

ROC curves were constructed for the modified Bishop score, sonographic cervical length, sonographic cervical width and HPD as predictors of successful vaginal delivery among parous women (Figure-3). All these variables were significant predictors, with the sonographic HPD and modified Bishop score being the most significant, having the largest areas under curve (AUC) [0. 913, 95% CI (0.850 to 0.976), p<0.001 and 0.908, 95% CI (0.846 to 0.970), p<0.001, respectively] .

The results of the current study showed that among parous women, an initial Bishop score of ≥ 5 was a significant predictor of successful vaginal delivery [at a sensitivity of 81.2%, PPV of 93.2%, NPV of 55.6%, FP of 20% and a LR+ of 4.1] .

Among parous women, an initial sonographic cervical length ≤ 2.15 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 83.5%, PPV of 93.4%, NPV of 58.3%, FP of 20% and a LR+ of 4.2] .

Among parous women, an initial sonographic cervical width ≥ 1.75 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 81.2%, PPV of 93.2%, NPV of 55.6%, FP of 20% and a LR+ of 4.1] .

Among parous women, an initial HPD ≤ 4.85 cm, successful vaginal delivery was significantly predicted [at a sensitivity of 84.7%, PPV of 94.7%, NPV of 61.8%, FP of 16% and a LR+ of 5.3] .

An initial bishop score ≥ 6 and a sonographic HPD ≤ 4 cm were both exclusively associated with successful vaginal delivery in all included women,

whether primiparous or parous [i.e. no cases of CS for failed induction or arrest of cervical dilatation were reported at these parameters].

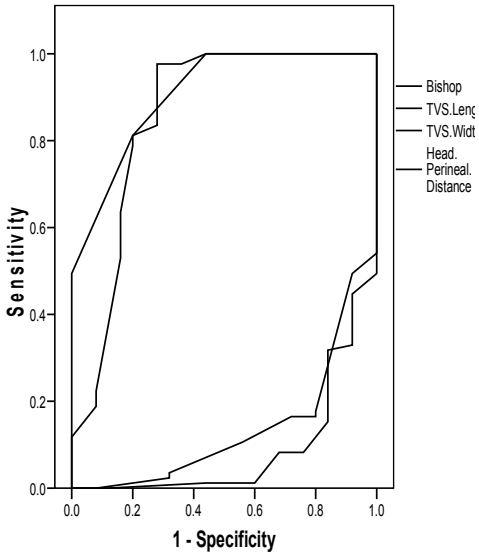

Fig. (3): ROC Curve for Modified Bishop Score as Predictor of Successful Vaginal Delivery in Parous Womem.

On the other hand, an initial sonographic cervical length > 3 cm was always associated with a CS for failed induction or arrest of cervical dilatation in all included women, whether parous or primiparous.

4.Discussion

The study was carried out to evaluate the ultrasound measurements of the fetal head perineum distance measured by transperineal ultrasound and cervical length measured by transvaginal ultrasound imaging as a predictive factors for successful IOL and to creat a cut-off level of these parameters which may be helpful in predicting successful induction of labour.

All patients underwent cervical assessment including cervical dilatation (cm), cervical length, station of presenting part, cervical consistency and position (using modified Bishop score system).

All participants in this study were subjected to transperineal U/S for assessment of fetal head station and transvaginal U/S for assessment of cervical length and width.

Ultrasound measured cervical length in the midtrimester ***(Smith et al.,2008)*** and before induction of labor ***(Pandis et al.,2001, Rane et al.,2004 Peregrine et al.,2006)*** can be used to predict cesarean section.

Cervical length is more accurately assessed by ultrasound than by digital examination, and the interobserver reproducibility of ultrasound is acceptable ***(Valentin et al., 2002).***

Sonek et al. found a moderate correlation between ultrasound and digitally assessed cervical length ***(Sonek et al., 1990).***

Digital assessment of cervical length was generally shorter than ultrasound measurements, probably because one-third of the cervix is supravaginal and inaccessible to the examining fingers when the cervix is closed ***(Ugwumandu et al., 2002).***

Elghorori et al. (2006) have suggested to modify the Bishop score by replacing the digital assessment of cervical length with ultrasound measured cervical length.

In our study there was a significant positive correlation between digital and sonographic cervical length in included women, whether in general or when split into primiparous and parous women.

Current ultrasound technology does not allow precise, objective assessment of cervical dilatation ***(Sherer, 2007).***

During the ultrasound examination the vaginal probe is placed in the anterior vaginal fornix, whereas digital assessment implies that one or two fingers are placed into the cervical canal. If the cervical consistency is soft, the cervical canal will dilate during this procedure.

By digital examination this cervix was assessed to be dilated one cm.

We think digital assessments of dilatation and consistency are parts of the same evaluation.

In our study there was a significant positive correlation between digital cervical dilatation and sonographic cervical width in included women, whether in general or when split into primiparous and parous women.

So, digital assessment of dilatation was the element of the Bishop score that best discriminated between successful or failed induction as described in ***Eggebø (2008).***

Fetal head station is assessed by digital examination of the relation between the fetal head and the maternal ischial spines ***(Eggebø et al., 2008)***. However, the ischial spines are difficult to visualize with ultrasound.

Lewin et al. (1977) suggested to use ultrasound to assess fetal head station by measuring the distance between the fetal head and the sacral tip.

We have measured the shortest distance from the fetal head to the perineum using the outlet of the birth canal as a reference line ***(Eggebø et al., 2006; Eggebø et al., 2008).***

Since the birth canal is curved, there will be an association, but not a direct relation, between the fetal head_perineum distance and fetal head station ***(Eggebø et al., 2008).*** The measurements may vary with the degree of compression of soft tissue, but the intra- and interobserver variability of the method are acceptable ***(Eggebø et al., 2006)***.

But in our study there was a significant negative correlation between station of the head and sonographic HPD in included women, whether in general or when split into primiparous and parous.

Receiver operator characteristics (ROC) curves were constructed for the modified Bishop score, sonographic cervical length, sonographic cervical width and HPD as predictors of successful vaginal delivery among all included women. All these variables were significant predictors, with the modified Bishop score and HPD being the most significant, having the largest areas under curve (AUC) [0.893 and 0.893 respectively].

The results of the current study showed that among all included women, an initial Bishop score of ≥ 5 was a significant predictor of successful vaginal delivery.

Among all included women, an initial sonographic cervical length ≤ 2.15 cm, successful vaginal delivery was significantly predicted.

Among all included women, an initial sonographic cervical width ≥ 1.9 cm, successful vaginal delivery was significantly predicted.

Among all included women, an initial HPD ≤ 4.85 cm, successful vaginal delivery was significantly predicted.

An initial bishop score ≥ 6 and a sonographic HPD ≤ 4 cm were both exclusively associated with successful vaginal delivery in all included women, whether primiparous or parous [i.e. no cases of CS for failed induction or arrest of cervical dilatation were reported at these parameters]

On the other hand, an initial sonographic cervical length > 3 cm was always associated with a CS for failed induction or arrest of cervical dilatation in all included women, whether parous or primiparous.

So, since the Bishop score is a complicated and subjective scoring system with assignable score values from 0 to 13, and its interobserver agreement has been regarded as 'fair to substantial' ***(Faltin-Traub et al., 2004)***, a simpler score may be more practical, objective and reliable.

In 1982, Lange et al. proposed a scoring model based on digital assessment of fetal station, cervical length, and cervical dilatation.

Bueno et al. (2005) combined ultrasound measured cervical length, parity, and the Bishop score.

Peregrine et al. (2006) suggested a predictive model including parity, maternal height, BMI, and ultrasound measured cervical length with different weighting of each factor.

In our study the cut off level of ultrasound measurements and clinical assessments may become useful, but includes a simplification because it assumes the same importance for each factor. The cut off level of head perineal distance is 4 cm below which the induction of labor is favorable, while the cut of level of cervical length is 2.5cm below which the induction of labor is favorable. These parameters in association with digitally assessed cervical dilatation will discriminate successful and failed induction of labor.

The cut-off levels for ultrasound measurements were based on our study in association with the previous publications ***(Lange et al., 1982, Pandis et al., 2001; Elghorori et al., 2006, Laencina et al., 2007).***

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