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Review Article

Prediction of success of induction of labour: Bishop's score versus transvaginal sonographic parameters

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ABSTRACT

Bishop's score is a standard method of pre-induction assessment of parameters to predict induction of labour. It is subjective and has interobserver variability and it does not take in to account the supra-vaginal cervix which forms more than 50% of cervical length. During the past 3 decades studies undertaken to find out a better predictor of labour induction found ultrasonographic assessment of cervix to be a better method. Cervical length, posterior cervical angle and head position are some of the parameters that were studied and compared with Bishops score. Among these posterior cervical angles of $>110^{\circ}$ and cervical length of <2 cm are the best predictors for success of induction of labour. These parameters would help to explain the chances of vaginal delivery and the risk of undergoing caesarean section in an objective way.

Keywords: Bishop's score, Cervical length, Posterior cervical angle, Head position, Successful labour induction

INTRODUCTION

Induction of labour is a process by which vaginal delivery is anticipated by artificial means so as to mimic the normal labour events before the woman goes in to spontaneous onset of labour. It is necessary in 20% of pregnancies for termination of pregnancy at appropriate time to save life of mother or fetus and at times both.¹ The success of induction of labour depends mainly on the status of cervix at the time of labour induction.²⁻⁴ It is essential to predict the success of vaginal delivery before contemplating on induction so as to counsel women regarding the progress and the failure or success of vaginal delivery.

Pre induction favorability of the cervix is traditionally assessed by Bishop's score since its description in 1964.⁵ This assessment is subjective and it shows high inter-and intra-observer variability.^{6,7} Recently ultrasound assessment of cervix and other parameters are reported to be better than Bishop's score. Ultrasonographic

measurement of cervical length is an objective method for assessing cervical status.^{8,9} Transvaginal ultrasonographic measurements like cervical length, posterior cervical angle, and occipital position are being used to predict the success of induction of labour. Their applicability in routine obstetric practice is not yet been recommended. Some studies reported ultrasonographic examination is as good as Bishop's score, few reported inferior and others reported better predictive value. This review is intended to report on the recent studies comparing Bishop's score with transvaginal sonographic parameters in predicting success of induction of labour.

DISCUSSION

Trans abdominal sonography (TAS)

In 1986 a semi quantitative ultra-sonographic scoring system was proposed by O'Leary and Ferrell.¹⁰ They evaluated the contour, thickness of lower uterine segment, length of cervix and dilatation by

transabdominal USG and concluded that both Bishop score and ultrasound predicts the chance of successful induction of labour. However, they found no advantage of ultrasound over Bishop score.

Transvaginal sonography (TVS)

The entire length of the cervix cannot be assessed effectively by clinical examination. Of all the components of Bishop Score, cervical length and cervical dilatation & effacement (which are also indirect assessment of cervical length) are more closely associated with successful induction of labour. Introduction of the transvaginal ultrasound became the major advance in the imaging system to evaluate the cervical characteristics to predict the successful induction of labour. In fact, the supra vaginal portion of cervix is better assessed with USG than clinical examination. Cervical length is measured easily by recognizing Internal and external OS (Figure 1). Since effacement starts at internal OS and progress downwards to external OS initial stages of internal OS assessment will be difficult especially if OS is closed. Hence sonographic cervical assessment was explored in many studies.



Figure 1: Cervical length measurement TVS.

USG COMBINED SCORING SYSTEMS

Various components of cervical sonography like cervical length, cervical dilation, fetal head position, posterior cervical angle, funneling and head perineal distance have been explored in many studies. Posterior cervical angle is measured between the long axis of the cervix and posterior wall of uterus at internal OS (Figure 2). Of late even stiffness of cervix has been studied by cervical elastography to certain extent.



Figure 2: Posterior cervical angle measurement TVS.

BISHOP'S SCORE VERSUS ULTRASONOGRAPHIC PARAMETERS

There were few systematic reviews on the role of transvaginal sonography in pre-induction assessment of cervix. Crane et al in 2006 reviewed the factors involved in the prediction of successful induction of labour.¹¹ They concluded that increasing parity and age, lower weight, height and BMI and higher gestational age all were associated with successful induction of labour. They also noted that state of ripening correlated with successful induction and Bishop score is better in assessing cervical favorability. Even though they acknowledged the usefulness of sonographic cervical assessment in prediction of labour induction, they stated that the superiority of sonographic cervical assessment had yet to be identified. The sensitivity was 88% and specificity was 100% in predicting successful when posterior cervical angle $>70^{\circ}$ was combined with Bishop score >5 . They concluded that best overall prediction is achieved by combining two methods and posterior cervical angle measurement should be confirmed by further studies in predicting outcome of labour.²³

BISHOP'S SCORE VS CERVICAL LENGTH (TABLE 1)

A multicenter study was undertaken by Pandis et al involving 240 women to find out the relationship between the pre induction Bishop score with the cervical length using trans vaginal USG and to compare both the values in predicting successful vaginal delivery within 24 hours of induction.¹² They demonstrated that both Bishop score and sonographically measured cervical length were significantly correlated with induction delivery interval. It was concluded that to predict the likelihood of vaginal delivery within 24 hours, cervical length measured by transvaginal sonography was a better parameter than Bishop score. They also observed that as the cervical length decreases, the likelihood of vaginal delivery increases. Women can be informed that when cervical length is less than 19 mm, they would achieve vaginal delivery within 24 hours and when it is more than 31 mm there is 85% chance of remaining undelivered after 24 hours of induction. They concluded that transvaginal sonographic measurement of cervical length is best parameter for predicting the possibility of vaginal delivery within 24 hours of induction.

Gabriel et al in 2002 conducted a prospective study in 179 women, to predict the mode of delivery. They compared Bishop score and measurement of trans vaginal sonography in women undergoing indicated induction of labour at term.¹³ They highlighted that transvaginal sonographic assessment of the cervix prior to labour induction had not been shown to be of value when the Bishop score is >5 . However, among women with low Bishop score, sonography of the cervix helps to differentiate between two subgroups with different obstetric prognosis. They concluded that cervical length

of >26 mm almost doubles the risk of caesarean section in a woman with unfavorable cervix.

In 2000, Ware and Raynor conducted a prospective observational study on 77 women, and compared the transvaginal cervical measurement with Bishop score in predicting the duration of labour and successful induction of labour at term.¹⁴ They found that cervical length with a cut off of 30 mm, had a sensitivity of 91% and specificity of 92% in predicting vaginal delivery. Women with cervical length of <3 cm had a shorter labour and more likely to deliver vaginally and women with Bishop score of >4 also had shorter labour and delivered vaginally. They concluded that the likelihood of vaginal delivery can be predicted by both parameters. However, they also stated that cervical length and parity were independent predictors of duration of labour and mode of delivery.

Bastani et al compared transvaginal ultrasonography with Bishop score for prediction of caesarean section after induction of labour.¹⁵ A total of 200 women with singleton pregnancies undergoing induction of labour were enrolled at term. The predictive value was determined by comparison of receiver operating characteristic curves (ROC) and equality of the area (AUC) under curve. The AUC for Bishop score was 0.39 (95% CI 0.3-0.48) and for trans vaginal assessment of cervical length was 0.69 (95% CI 0.29-0.47). There was a statistically significant difference of the ROC for cervical length, Bishop score and posterior cervical angle ($p < 0.001$). There was no statistically significant difference in ROC area between Bishop score and posterior cervical angle.

Rozenberg et al conducted a study in 266 women to compare the pre induction Bishop score with transvaginal cervical length in predicting time to delivery.¹⁶ They concluded that Bishop score was better predictor than cervical length in predicting induction to delivery and vaginal delivery. The hazard ratio was (HR) 1.2 95% CI 1.1-1.3. meaning higher the Bishop's score higher hazard to deliver vaginally. The limitation of the study was inclusion of heterogeneous population between 34 to 41 weeks. Since cervical ripening is a dynamic process that occurs in the third trimester before the onset of labour sonographic measurement may differ according to the gestational age. They also stated that cervical length is unlikely to be a marker for cervical ripening.

In 2006, Tan and colleagues conducted a prospective study in 249 women to compare the Bishop score and cervical length by transvaginal sonography.¹⁷ The aim of the study was mainly to assess their tolerability and ability to predict the need for caesarean delivery. Women tolerated transvaginal sonography than assessing Bishop Score. They found cervical length as well as Bishop score to be useful predictors of caesarean delivery following labour induction but cervical length of >20 mm at term emerged as an independent predictor of caesarean delivery.

Rane et al in 2003, conducted a study in 382 women undergoing induction of labour in prolonged pregnancy.¹⁸ They have demonstrated that sonographically measured cervical length was better than Bishop score and concluded that nulliparous women with a cervical length of <20 mm have an 80% chance of delivering within 24 hours of induction and >30 mm have a 90% chance of remaining undelivered. They also concluded that parity was one of the independent predictors of outcome of the labour. In multipara 30% higher chance of delivering vaginally within 24 hours of induction than nullipara for the same score. Strobel et al in 2006 compared Bishop score and trans-cervical length in prolonged pregnancies and concluded that both can predict the time to onset of labour and delivery with same accuracy.¹⁹

In 2011 Park, conducted a study among 154 nulliparous women at term who were planned for induction of labour.²⁰ The aim was to determine the requirement for prostaglandin administration for pre induction cervical ripening using sonographically measured cervical length and Bishop score and compare both. Pre induction score was assessed by Bishop score and transvaginal sonography. They defined unfavourable cervix as having either Bishop score of <4 or cervical length of >28 mm. The primary outcome was successful induction and it was defined as achievement of active phase of labour within 22 hours of prostaglandin administration (diniprostone vaginal insert). It was concluded that cervical length measured by transvaginal sonography can reduce the need for induction agent by 50% without adversely affecting the outcome of induction when compared to assessment by Bishop score.

Bartha et al conducted a study in 2001 to 2002, involving 80 women who were randomized based on Bishop score or transvaginal ultrasound choice of induction agent.²¹ They considered the criteria of unripe cervix as Bishop score of <6 or cervical length of >30 mm with cervical wedging of <30% of the cervical length. They compared the Bishop score with the transvaginal ultrasound in pre induction cervical assessment for choice of induction agent. The primary outcome was percentage of the women who were induced with prostaglandin. They concluded that intracervical prostaglandin requirement as inducing agent has significantly reduced by 40-50% without affecting success of induction of labour in patients with the use of transvaginal ultrasound as a pre induction cervical assessment instead of Bishop score.

A prospective observational study was conducted by Gomez et al in 2006 involving 191 pregnant women undergoing labour induction to find out the relationship between the cervical length and Bishop score with duration of labour induction.⁸ They defined unripe cervix as either a cervical length of >26 mm or Bishop score of >6. The outcomes measured were the duration of induction, delivery within 24 hours of induction and type of delivery. In this study, we found an association between the cervical length and Bishop score with the

duration of induction. This study showed low Bishop Score and cervical length longer than 26 mm had a higher risk of delivery after 24 hours of induction. It was opined that sonographic assessment of cervix is useful in prediction of outcome of labour induction but its usefulness may be limited to unfavorable cervixes.

The main advantage of sonographic cervical length assessment was less discomfort to patients. Few studies did not find transvaginal ultrasound superior to digital examination in pre induction cervical assessment. A study by Chandra et al in 2001 also compared transvaginal ultrasound with digital examination.²² There were 122 post term women involved in this study and all

of them underwent transvaginal USG and digital assessment. It was found that digital assessment predicted success of labour induction. None of the USG parameters showed a significant association with successful labour induction or delivery within 24 hours. They also found certain clinical parameters like maternal age and weight in addition to cervical dilatation and effacement independently predicted successful labour induction. Even sonographic cervical length assessment produced conflict results there were attempts to look for other ultrasound parameters like posterior cervical angle and funneling of cervix.²²⁻²⁴ The angle between posterior uterine wall and cervical canal is called posterior cervical angle.

Table 1: Studies on Bishops score and transvaginal cervical length.

Name of author and year	N	Parameters studied	Primary outcome	Cut-off value	Result
Nikbakht et al ²² 2016	148	Bishop score vs CL	VD	Bishop score >4 CL < 20 mm	Trans vaginal CL is more reliable than Bishop score in nulliparous women (p=0.016)
Abdelazim et al ²³ 2012	120	CL vs Mod. Bishop score	VD	CL < 25 mm Bishop score > 5	P value < 0.05 for both CL and Bishop score
Groeneveld et al ²⁴ 2010	110	CL vs Bishop score	VD	Bishop score > 3	Bishop score a better predictor of vaginal delivery within 96 hours than CL by TVS
Park et al ²⁰ 2007	160	CL vs Bishop score	Failed induction and CD	CL > 2.8cm	OR for Bishop score 0.85 (p=NS) OR for CL 2.8cm (p<0.005)
Tan et al ¹⁷ 2007	249	CL vs Bishop score	VD	CL < 20 mm Mod. Bishop score ≥ 5	Sensitivity for TVS (80%) higher than modified Bishop score (64%)
Rane et al ¹⁸ 2003	382	Bishop score vs CL (TVS)	Induction to delivery interval	Longer CL	Sonographic CL better than Bishop score or CL by vaginal examination in predicting the outcome of induction
Gabriel et al ¹³ 2002	179	Bishop score and CL (TVS)	Risk of caesarean section	Bishop score < 5 and CL < 26 mm	In women with Bishop score < 5, the CL of < 26 mm associated with lower risk of caesarean section
Pandis et al ¹² 2001	240	Bishop score vs CL	VD	CL > 28 mm and Bishop score > 3	CL a better predictor of vaginal delivery and delivery within 24 hours, sensitivity and specificity for CL was 0.87 and 0.71 compared to 0.58 and 0.77 for Bishop score
Ware et al ¹⁴ 2000	77	Bishop score vs CL	VD	CL < 3cm Bishop score > 4	Both sonographically measured CL (p<0.001) and Bishop score (p value < 0.001) predict likelihood of VD

CL: Cervical length; VD: Vaginal delivery; CD: Caesarean delivery

BISHOPS SCORE VS POSTERIOR CERVICAL ANGLE (TABLE 2)

In 1991, Brown et al, conducted a pilot study in 50 patients who underwent induction of labour which included both primigravidae and multi gravidae^[23]. These patients underwent pre induction cervical assessment by digital Bishop Score and transvaginal ultrasonography. Seven ultra sound parameters were examined, which

included cervical length, width, position, dilation, application, lower segment thickness and cervical angle. It was measured using a protractor on hard copy picture at the level of internal OS. They found Posterior cervical angle to be more accurate than Bishop Score in predicting vaginal delivery. Posterior cervical angle correlated significantly with outcome of induction of labour. Patients experienced less discomfort with transvaginal ultrasound when compared to digital examination and

this was statistically significant. Rizwana and colleagues in 2016 studied 200 women and found that a CL of 3 cm and posterior cervical angle of more than 100° as successful predictors of labour induction.²⁵

Bastani et al in 2011 did not find posterior cervical angle as a better predictor of type of delivery following induction of labour.²⁴ Posterior cervical angle of 100 degrees had a sensitivity 65%, and a specificity of 72% for predicting vaginal delivery. The ability to predict caesarean section was not different that of Bishop score.

In 1994, Boozarjomehri et al compared digital evaluation with sonographic parameters. In addition to cervical

length they studied cervical wedging (also known as funneling) and it was found that cervical funneling was significantly associated with a shorter latent labour and short duration of labour.²⁵ Keapanasseril et al also studied the effect of cervical funneling on pre induction assessment of cervix in 2007^[26]. The managing physicians were blinded to sonographic parameters. But the cervical funneling was observed in only 22.7% of the women in the study. It may be due to inclusion of patients towards term during which funneling may disappear due to descent of head. Further studies are needed to study the effect of funneling in labour prediction.

Table 2: Studies comparing Bishop’s score and posterior cervical angle and funneling.

Name of author and year	N	Parameters studied	Primary outcome	Cutoff value	Result
Rizwana et al ²⁵ 2016	200	CL, funneling and posterior cervical angle	Successful induction of labour	CL=3 cm; posterior cervical angle >100	CL and posterior cervical angle were found to be statistically significant in predicting successful labour induction (sensitivity and specificity for CL was 84 and 70.7% and for posterior cervical angle was 85.6 and 66.7% respectively)
Keapananas seril et al ²⁶ 2007	138	CL and posterior cervical angle (TVS) vs Bishop score	Successful labour induction	CL <3 cm Post. Cervical angle >100 and Bishop score >3	OR for CL 0.01 (p value 0.00) for post. Cervical angle 1.041 (p value 0.03) and for Bishop score 0.57 (p value 0.25)
Paterson-Brown et al ²³ 1991	50	Bishop score vs seven USG parameters including CL and posterior cervical angle	VD	Posterior cervical angle >70° Bishop score >5	Posterior cervical angle was more accurate than Bishop score (Kappa=0.48 vs 0.21) No significant association between CL and Bishop score or the induction to delivery interval
Bastani et al ²⁴ 2011	200	CL and post. cervical angle (TVS) vs Bishop score	CD	>19 mm	Specificity for Bishop score ≥6 - 85% CL ≥2.2 cm 82.5% and posterior cervical angle ≥120°- 53.8%

VD=Vaginal Delivery; CD=Caesarean Delivery

BISHOP’S VS CERVICAL LENGTH, POSTERIOR CERVICAL ANGLE AND HEAD POSITION (TABLE 3)

Fetal head position by transabdominal ultrasound: The results were conflicting in literature about the effect of fetal head position in predicting delivery time.

Peregrine et al, conducted a study in 267 women undergoing labour induction and compared clinical and ultrasound parameters to predict the risk of caesarean delivery after induction of labour.²⁷ They reported parity, height, body mass index, and transvaginal ultrasonographic cervical length to be accurate parameters in predicting the risk of caesarean delivery,

and fetal head position was not a good predictive parameter.

In 2014, Gokturk et al conducted a prospective observational study among 223 women to evaluate the predictive value of sonographic cervical length, posterior cervical angle and fetal head position for determine successful induction of labour.²⁸ They found that patients with occiput posterior position had longer labour time and this was not statistically significant. In 2016, Khazardoost and colleagues found head position by USG and Cervical length of 16 mm had a sensitivity of 85% and bishop score of more than 5 had a sensitivity of 84%.²⁸

BISHOP SCORE VS CERVICAL LENGTH AND CERVICAL WEDGING (TABLE 4)

In 1998, Gonen et al, prospectively evaluated 86 women by digital cervical assessment and transvaginal ultrasonography to measure cervical length and wedging to predict success of induction and duration of labour.³² Successful induction and the duration of labour were significantly correlated with Bishop score and cervical length. Cervical wedging was associated with only with successful induction but not with duration of labour. However only the Bishop score and parity were the independent variables associated with successful induction and duration of labour on logistic regression model.

In 1994, Boozarjomehri et al attempted to explore the effect of sonographic cervical length and cervical wedging in duration of induced labour³⁰. He included 53 patients who were planned for induction of labour. All of them underwent both sonographic and digital cervical evaluation. Both cervical wedging and cervical length which was measured by ultra sound were associated with duration of latent labour and total duration of labour. The p value for shorter latent (15.9±1.7 vs 34.1±3.8

hours, p=0.0001) and total duration of labour (22.0±1.8 vs 38.3±3.6 hours, p=0.0001).

A meta-analysis by Hatfield et al in 2007 included a total of 20 articles with 3101 participants for prediction of successful induction who used cervical wedging. A positive likelihood ratio of 2.64 and negative likelihood ratio of 0.64. Were reported for cervical wedging. It was concluded that further-studies are necessary for evaluation on cervical wedging.³¹

Verhoeven et al in 2013 published a systematic review and meta-analysis on outcome of labour which included 31 articles on transvaginal sonographic assessment of cervical length and wedging. They reported that sonographic measurement of cervical length and cervical wedging at or near term have moderate capacity to predict the delivery outcome after labour induction.³² Hence, they concluded that assessment of cervical length and wedging of cervix which can be done easily with sonography but it has limited value in predicting the outcome of labour and in general, the accuracy of the test was too limited to justify its use in routine practice.

Table 3: Studies comparing Bishop score and fetal head position.

Name of author and year	No	Parameters studied	Primary outcome	Cutoff value	Result
Khazardoost et al ²⁸ 2016	100	CL (TVS) and Fetal position (TAS) vs Bishop score	VD	16 mm for CL and Bishop score ≥5	85% sensitivity and 67% specificity for USG 84 and 70% for Bishop
Gokturk et al ²⁸ 2014	233	CL and posterior cervical angle (TVS) fetal head position (TAS) vs Bishop score	Vaginal delivery	Posterior cervical angle >120° Bishop score ≥ 5 CL >25 mm	Bishop score-high sensitivity (76.4%), CL-high specificity (89.2%) for prediction of vaginal delivery, Posterior cervical angle >120° not statistically significant
Peregrine et al ²⁷ 2006	267	Clinical and USG parameters (CL and fetal head position)	Risk of CD after IOL		Both clinical (parity, height, BMI) and sonographic CL were accurate in predicting risk of caesarean section but not fetal head position

IOL=Induction of labour

Table 4: Studies comparing Bishop score, cervical length and cervical wedging.

Name of author and year	No	Parameters studied	Primary outcome	Cutoff value	Result
Verhoeven et al ³² 2013	31	Sonographic CL and cervical wedging compared with Bishop score	Meta analysis	Sensitivity of CL for the prediction of caesarean delivery ranged from 0.14 to 0.92 and specificity ranged from 0.35 to 1	CL and cervical wedging measured sonographically at or near term have moderate capacity to predict the outcome of delivery after induction of labour

Continued.

Name of author and year	No	Parameters studied	Primary outcome	Cutoff value	Result
Bartha et al ²¹ 2005	80	CL and cervical wedging (TVS) Bishop score	Need for ripening and caesarean section	Bishop score <6, CL >30 mm and cervical wedging <30%	85% in Bishop score group received inducing agent in contrast to 50% in transvaginal group (p value 0.001); rate of caesarean section was similar in both groups

CL: Cervical length

CONCLUSION

Bishop's score and trans vaginal sonographic parameters predict success of induction of labour but the transvaginal sonographic parameters are more objective and are useful especially in women with unfavorable cervix.

Bishop's Score is more subjective and the method is more painful when compared to transvaginal sonography. Of the transvaginal sonographic measurements cervical wedging and head position are not predictive of success of induction. Cervical length and posterior cervical angle are the best parameters that predict success of induction.

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