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Original Article

Obstetrics and Gynaecology Section

Role of Transvaginal Sonographic Parameters in Predicting Outcomes of Induction of Labour: A Prospective Observational Study

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ABSTRACT

Introduction: Induction of labour is an artificial method of initiating uterine contractions before the onset of spontaneous labour, which leads to progressive cervical dilatation and effacement followed by delivery. Bishop score is the most commonly used method for assessing the favourability of the cervix. However, this method is subjective and less accurate. Transvaginal ultrasonography (TVS) has been demonstrated to be more sensitive than the Modified Bishop score in predicting successful labour induction in recent years as it avoids interobserver variations.

Aim: To know the role of TVS parameters in predicting the outcome of induction of labour and to compare with the predictive power of the Modified Bishop score.

Materials and Methods: This was a prospective observational study conducted between October 2019 to April 2021 in the Department of Obstetrics and Gynaecology, ESIC PGIMSR, Basaidarapur, New Delhi, India. The study was conducted on 124 pregnant women. Preinduction TVS was performed using a transvaginal probe of 6 MHz and a transabdominal probe of 3.75 MHz. Ultrasound was used to determine cervical length, posterior cervical angle and foetal head position. Following the ultrasonographic examination, a digital examination of the cervix was done, and a score was assigned based on the Modified Bishop score. The induction of labour was performed as per hospital protocol. For the purpose of this study, the successful outcome was taken as a vaginal delivery within 24 hours from the start of induction. Data analysis was done by Statistical Package for Social Sciences (SPSS) version 25.0. McNemar's test was used to compare sensitivity and specificity. Qualitative variables were correlated by the Chi-square test/Fisher's exact test.

Results: A total of 124 patients were selected, who underwent induction of labour. Out of these 92 (74.2%) patients who delivered vaginally, 81 patients delivered within 24 hours of induction and 11 patients delivered after 24 hours of induction, rest 32 patients delivered by caesarean. So, the unsuccessful outcome was in 8.87% the of study population. Modified bishop score, TVS cervical length, posterior cervical angle and foetal head position, all were found significant in predicting the successful induction of labour. Cervical length measured by ultrasonography can be used as a significant predictor of the successful induction of labour ($p<0.001$) with an optimum cut-off of <3.65 with sensitivity and specificity of 99.1% and 79.5% respectively. The posterior cervical angle can also be used as a significant predictor of successful induction of labour. Modified bishop score can be used as a significant predictor of successful induction of labour ($p<0.001$) with an optimum cut-off of >2 with sensitivity and specificity of 98.13% and 82.35% respectively. Although, all ultrasound parameters when combined and compared with the Bishop score were found to be more significant in predicting successful induction of labour.

Conclusion: TVS parameters when combined were found to be more specific and sensitive as compared to the Modified Bishop score in predicting successful labour induction.

Keywords: Cervical length, Modified bishop score, Vaginal delivery

INTRODUCTION

Induction of labour is an artificial method of initiating uterine contractions before the onset of spontaneous labour, leading to progressive cervical dilatation and effacement followed by delivery. Modified Bishop score is the most commonly used method for the evaluation of preinduction favourability of the cervix. However, it has a high inter and intraobserver variability and its sensitivity is 23-64% [1]. TVS has been demonstrated to be more sensitive than the Modified Bishop score in predicting successful labour induction in recent years, as it avoids interobserver variations [2,3].

The TVS measurement of the cervix could represent a more accurate assessment of the cervix than digital examination because the supra vaginal portion of the cervix usually comprises about 50% of the cervical length and it is very difficult to assess digitally the supravaginal part of the cervix [4]. In addition, it is difficult to assess the effacement in a closed cervix, as effacement starts at the level of the internal os. Assessment of the cervix digitally is reported to be associated with fear of examination, pain, anxiety and discomfort [5]. Yang SH et al., conducted a study and found that TVS assessment of cervical length is a better method in predicting induction of labour than the Bishop score [6].

Measurements of the angle between the posterior uterine wall and the cervical canal (posterior cervical angle), have been associated with successful labour induction prediction [7]. A study by Rane SM et al., showed that, in women undergoing induction of labour, the posterior cervical angle is better than the Bishop score in the prediction of the outcome of labour [8].

Foetal head position is evaluated by placing the abdominal transducer transversely in the suprapubic region of the maternal abdomen. According to the study conducted by Akmal S et al., determining occiput position sonographically, during the early stages of active labour can help to estimate the risk of a caesarean section [9]. Various other parameters like cervical funnelling, cervical wedging and translabial distance of foetal head have also been studied.

This study was done to determine the efficacy of combined as well as an individual TVS parameter in predicting the successful outcome of induction of labour and whether, is this a better tool than clinical assessment obtained by the Bishop score.

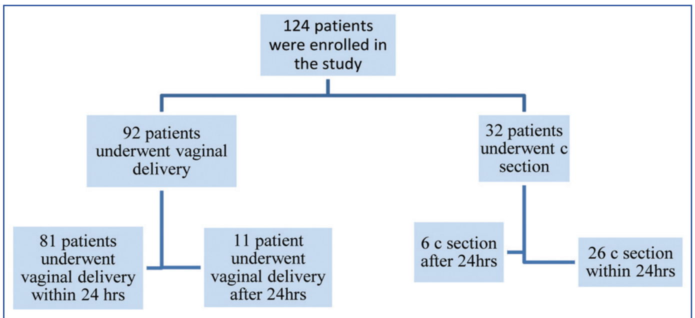
MATERIALS AND METHODS

This was a prospective observational study conducted between October 2019 to April 2021 in the Department of Obstetrics and Gynaecology, ESIC PGIMSR, Basaidarapur, New Delhi, India. This study was conducted after getting approval from the Ethical Committee (DM(A)H 19/14/17/IEC/2012PGIMSR). A total of 124 pregnant women who were admitted to labour room and Antenatal Clinic (ANC) ward and planned for induction of labour and gave consent were enrolled.

Inclusion criteria: Pregnant female with gestation from 37 completed weeks upto 42 weeks, singleton, live foetus, longitudinal lie, cephalic presentation with an intact amniotic membrane with reactive Non Stress Test (NST), and initial cervical examination showing ≤2 cm dilatation and ≤50% effacement that is Bishop score ≤6 were included in the study.

Exclusion criteria: Women with major foetal anomalies, previous uterine surgery, antepartum haemorrhage and contraindication to vaginal delivery were excluded from the study.

Sample size calculation: The study of Kanwar SN et al., observed that the sensitivity and specificity of bishop score were 34.43% and 93.88% respectively and cervical length was 57.38% and 100% respectively [10]. Taking these values as a reference, the minimum required sample size with desired precision of 12.5%, 80% power of study, and 5% level of significance was 118 patients. To reduce the margin of error, the total sample size taken was 124 [Table/Fig-1].



[Table/Fig-1]: Flow diagram depicting study enrolments of the participants.
c section: Caesarean section

Study Procedure

After a careful history, general and systemic examination, TVS was performed before induction of labour, using Philips clearVue350 machine with a transvaginal probe of 6 MHz and transabdominal probe of 3.75MHz.

Cervical distortion was avoided by placing the transducer, 3 cms proximal to the cervix. A sagittal view of the cervix was obtained and echogenic endocervical mucosa was visualised along the length of the endocervical canal. The image of the cervix was magnified to about 75% of the screen. The length of the cervix was measured from the internal os to the external os.

The posterior cervical angle was measured with a protractor applied to a hard copy picture taken in a sagittal plane at the level of the internal os and approximated to the nearest 10° [Table/Fig-2]. For determination of foetal head position, the ultrasound transducer was first placed transversely in the suprapubic region of the maternal abdomen. The foetal orbits in the case of Occiput Posterior (OP) position, the midline cerebral echo in the case of Occiput Transverse (OT) positions and the cerebellum or occiput in the case of Occiput Anterior (OA) position served as landmarks for foetal head position [Table/Fig-3] [8]. Following the ultrasonographic examination, an obstetrician who was blinded to the ultrasound measurements did a digital examination of the cervix with all aseptic precautions and a score was assigned based on the Modified Bishop score [11].

[Table/Fig-2]: Measurement of posterior cervical angle.

[Table/Fig-3]: Measurement of foetal head position.

The induction of labour was performed in accordance with the hospital's protocol. 0.5 mg dinoprostone gel was instilled into the cervix every six hours, for a total of three doses. If regular uterine contractions and cervical change did not occur six hours following the last prostaglandin dosage, an oxytocin infusion was given. Amniotomy with oxytocin infusion or oxytocin alone was started when Bishop's score was more than 5. For the purpose of this study, a successful outcome was taken as a vaginal delivery within 24 hours from the start of induction.

Failed induction: was defined as failure to achieve regular uterine contraction even after insertion of 3 intracervical PGE2 gel at six hours intervals, and 12 hours of oxytocin administration after rupture of the membranes.

Failure to progress: was defined as no cervical dilatation during the active phase of the labour (≥4 cms) for the last two hours and no descent of the foetal head during 2nd stage of labour for atleast one hour despite adequate uterine contractions [12].

STATISTICAL ANALYSIS

The collected data were transformed into variables, coded and entered in Microsoft excel. Data were analysed and statistically evaluated using SPSS version 25.0. Quantitative data were expressed in mean±standard deviation (SD) or median with interquartile range. Difference between two comparable groups was tested by student's t-test (unpaired). Qualitative data were expressed in percentage and statistical differences between the proportions were tested by Chi-square test. Receiver Operating Characteristic (ROC) curve was prepared using different parameters for prediction of successful induction of labour and based on cut-off value, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were calculated. Pearson or Spearmann correlation coefficient was used to see the correlation between two quantitative variables. The p-value <0.05 was considered statistically significant.

RESULTS

There were 74 (59.7%) primigravidas and 50 (40.3%) multigravidas in the study population [Table/Fig-4].

Characteristics	Value	
Parity		
Primigravida	74 (59.7%)	
Multigravida	50 (40.3%)	
Age (mean, median)	25.2,24	
21-25 years	84 (67.7%)	
26-30 years	26 (21%)	
31-35 years	14 (11.3%)	
Mode of delivery	C-section	Vaginal
Within 24 hrs	26	81
After 24 hrs	6	11
Gestation age at induction (Mean±SD, median, range)	38.71±1.25 weeks, 38.35 (37.71-40.14) weeks, 37-40+6 weeks	

[Table/Fig-4]: Demographic characteristics of the patients.

In present study, population maximum induction was done electively at term followed by Intrahepatic Cholestasis of Pregnancy (IHCP) [Table/Fig-5].

Indication for Induction of Labour (IoL)	n (%)
Elective induction at term	37 (29.8)
Intrahepatic cholestasis of pregnancy	25 (20.2)
Non severe preeclampsia	24 (19.4)
Foetal growth restriction	16 (12.9)
Decreased foetal movement	8 (6.5)
Oligohydramnios	10 (8.1)
Pathological Cardiotocography (CTG)	4 (3.2)

[Table/Fig-5]: Indications for induction of labour.

Around 15 (12%) patients underwent caesarean section due to foetal distress followed by Meconium-stained liquor 5 (4%) [Table/Fig-6].

Indications for caesarean section	n (%)
Foetal distress	15 (12)
Meconium-stained liquor	5 (4)
Failure to progress	4 (3.2)
Deep transverse arrest	2 (1.6)
Pathological cardiotocography	2 (1.6)
Failed induction	4 (3.2)

[Table/Fig-6]: Indications for Caesarean section.

Cervical length measured by TVS in the maximum number of patients ie 49 lies between 3.1-3.5 cms. Posterior cervical angle was <120° in 65.3% of patients. It was also found that the occiput anterior position is the most common presentation in 75% [Table/Fig-7].

TVS cervical length (cms)	N	%
2-2.5	1	0.8
2.6-3	27	21.8
3.1-3.5	49	39.5
3.6-4	34	27.4
4.1-4.5	13	10.5
Posterior cervical angle (°)		
<120	81	65.3
≥120	43	34.7
Mean	115.48±10.29	
Median	117 (110-124)	
Head position		
Occiput Anterior (OA)	93	75
Occiput Transverse (OT)	12	9.7
Occiput Posterior (OP)	19	15.3

[Table/Fig-7]: Ultrasonographic findings.

It was found that the maximum number of patients fall in the category of Bishop score of 3-4 ie 84 and mean Bishop score was 3.61 and vaginal delivery was 72 with Bishop score of 0-4 [Table/Fig-8,9].

Bishop score	No. of patients	%
0-2	18	14.5
3-4	84	67.7
5-6	22	17.7
Mean±SD	3.61±1.21	
Median	4 (3-4)	

[Table/Fig-8]: Bishop score of the patients.

Bishop score	Vaginal delivery	Caesarean section
0-4	72	30
5-6	20	2
Total	124	

[Table/Fig-9]: Comparison of Bishop score with the mode of delivery.

In women, delivered vaginally mean cervical length measured by TVS was 3.37±0.45 cms and by digital examination was 2.66±0.38 cms, significantly short as compared to those who required caesarean section (p-value <0.001) by Chi-square test.

It was found that for patients with TVS cervical length between 2-2.5 cm, 100% underwent normal vaginal delivery and for patients with a cervical length between 3.1-3.5 cm, 89.75% underwent normal vaginal delivery while 10.2% underwent caesarean section, while with the digitally measured cervical length between 1.5-2 cm 100% delivered vaginally while between 2.6-3 cm, 70.5% delivered vaginally while 29.4% delivered by caesarean section [Table/Fig-10].

Cervical length TVS	Vaginal delivery	Caesarean section
2-2.5 cm	1 (100%)	-
3.1-3.5 cm	44 (89.75%)	5 (10.2%)
Cervical length digitally		
1.5-2 cm	6 (100%)	-
2.6-3 cm	36 (70.5%)	15 (29.4%)

[Table/Fig-10]: Comparing cervical length measured digitally and by TVS.

The mean posterior cervical angle was117.97±9.35 cm in patients delivered vaginally which was significantly (p-value-0.001) higher as compared to those who underwent caesarean section. OA position was significantly associated with vaginal delivery 75 (80.6%) [Table/Fig-11].

It was observed that 54 (43.6%) of patients delivered within 12 hours of induction, 53 (42.7%) of patients delivered between 12-24 hours and 17 (13.7%) delivered in more than 24 hours.

Out of 107 cases where induction to the delivery interval was ≤24 hours, 81 (75.7%) cases were delivered vaginally and 26 (24.3%) underwent caesarean section. Out of 17 cases where induction to the delivery interval was >24 hours, 11 (64.7%) cases were delivered by the vaginal route and 6 (35.3%) by caesarean section. For the patients delivered vaginally the mean time duration from induction to active phase was 10.36±5.54 hours, the mean time duration from active phase to vaginal delivery was 3.72±1.11 hours and the mean time duration from induction to the delivery interval was 14.11±6.05 hours.

There was statistically very strong positive correlation between TVS cervical length in IOL to delivery interval (r-value=0.815, p-value <0.001) and strong positive correlation between IOL to active phase (r-value=0.793, p-value <0.001) [Table/Fig-12].

Variables	Mode of delivery		p-value
	NVD	LSCS	
Cervical length on USG	3.24±0.45	3.75±0.36	<0.001¥
PCA on USG	117.97±9.35	108.31±9.62	<0.001¥
USG head position			
OA	75 (80.6%)	18 (19.4%)	<0.01#
OP	5 (41.7%)	7 (58.3%)	
OT	12 (63.2%)	7 (36.8%)	

[Table/Fig-11]: Comparison of USG parameters with the mode of delivery.
¥-Unpaired students t test was used #- Chi-square test was used

Variables		IOL to active phase	Active phase to delivery	IOL to delivery interval
TVS cervical length	r-value	0.793	0.191	0.815
	p-value	<0.001	0.37	<0.001
	n	120	120	124
Total Bishop score	r-value	-0.608	-0.273	-0.661
	p-value	0.001	0.003	0.001
	n	120	120	124
USG PCA	r-value	-0.609	-0.160	-0.638
	p-value	<0.001	0.080	<0.001
	n	120	120	124

[Table/Fig-12]: Correlation of different parameters with IOL to the active phase, active phase to delivery, and IOL to delivery interval.

Combined Ultrasonography (USG) parameters were found to be more sensitive (100%, AUC-0.97%) as compared to single USG parameter or Bishop score (98.13%, AUC-0.93) [Table/Fig-13].

Variables	Modified BISHOP score	Cervical length measured by USG	PCA on USG	Head position on USG	Combined USG parameters
AUC	0.93	0.92	0.95		0.97
95% CI	0.84-0.99	0.87-0.97	0.91-0.98		0.94-0.99
Cut-off value	>2	3.65	111	OA	
Sensitivity	98.13%	99.1%	79.4%	79.4%	100%
Specificity	82.35%	79.5%	99.1%	52.9%	95.1%
PPV	97.22%	96.36%	92.86%	91.4%	97.4%
NPV	97.22%	92.86%	96.36%	29.3%	100%
Accuracy	95.97%	95.97%	95.97%	75.8%	97%

[Table/Fig-13]: Diagnostic performance of different parameters for predicting successful induction of labour.
Foetal head position is qualitative variable so these things could not be calculated

DISCUSSION

In the present study, the successful outcome of induction was defined as; vaginal delivery occurring within 24 hours. This endpoint has been traditionally used in several studies to examine the efficacy of an inducing method, Pandis G et al., also demonstrated that cervical length by ultrasound performed better than Bishop Score to predict vaginal delivery within 24 hours of induction [13].

In the present study, the mean time duration from induction to the active phase was 10.36±5.54 hours. The mean time duration from the active phase to vaginal delivery was 3.72±1.11 hours. The mean time duration from induction to delivery interval was 14.11±6.05 hours. These findings were consistent with the study by Aggarwal K and Yadav A, in which the mean time duration from induction to active phase was 8.86±3.93 hours. The mean time duration from the active phase to vaginal delivery was 4.68±1.86 hours. The mean time duration from induction to the delivery interval was 13.26±4.98 hours [14].

In the present study, cervical length was measured by digital examination and TVS and the mean sonographic cervical length was 3.37±0.4 cm and the mean cervical length measured by digital examination was 2.66±0.38. There was a significant difference of 0.7 cms in mean cervical length measured by the two methods. The difference in cervical length measured digitally and by USG is mainly due to the supravaginal portion of the cervix which cannot be measured digitally.

The digital examination can only measure the length between the external os to the cervicovaginal junction. Present study findings were consistent with the study conducted by Aggarwal K and Yadav A, which reported a mean sonographic cervical length of 3.4 cm and cervical length measured by digital examination as 2.6 cm [14].

In the present study, the best cut-off point for predicting successful induction of labour was ≤3.6 cm for cervical length measured by TVS.

Present study findings were consistent with the study conducted by Keepanasseril A et al., [15]. In the ROC curve, the best cut-off point for predicting successful induction of labour was >2 for the modified Bishop score. The area under the ROC curve was 0.93 which were consistent with the study conducted by Aggarwal K and Yadav A [14].

The ROC curve of present study showed that as compared to TVS cervical length, the Modified Bishop score was the best parameter for predicting successful induction of labour (area under ROC curve of modified bishop score was more than the TVS cervical length). From the previous studies done on the prediction of successful labour induction, Paterson-Brown S et al., Aggarwal K and Yadav A and Chandra S et al., reported Bishop score as a better predictor than the transvaginal ultrasonographic assessment of cervical length [7,14,16].

Previous studies done by Elghorori MR et al., Ware V and Raynor BD, Rane SM et al., Pandis G et al., Keepanasseril A et al., and Gabriel R et al., reported transvaginal ultrasonographic cervical assessment as a better predictor than Bishop score for predicting successful labour induction [1,4,8,13,15,17]. In the study conducted by Athulathmudali SR et al., the primary outcome was taken as vaginal delivery within 24 hours and TVS cervical length, cervical volume and bishop score were compared [18]. TVS cervical length was found to be a superior predictor to other parameters. In another study by Abdullah ZH et al., TVS cervical length and Bishop score was compared and they did not find much difference in the predictive value of both parameters [19]. Ransiri PA et al., and Vince K et al., found the Bishop score to be a better predictor than TVS cervical length [Table/Fig-14] [20,21].

In the literature, there are very few studies about the effect of posterior cervical angle in labour induction. In present study, posterior cervical angle >111 is having better predictive value for successful induction of labour with a sensitivity of 0.79 and specificity of 0.99 and AUC 0.95. Paterson-Brown S et al., reported that posterior cervical angle was more accurate than Bishop score in predicting vaginal delivery [7]. Rane SM et al., performed transvaginal ultrasound in 604 patients, whose posterior cervical angle measurements were >120 and reported better responses to labour induction within 24 hours [8]. In a study by Gokturk U et al., posterior cervical angle 120 appears to

Author	Publication year	Place of study and n of study	TVS cervical length				Modified Bishop score			
			Cut-off	AUC	Sensitivity	Specificity	Cut-off	AUC	Sensitivity	Specificity
Keepanasseril A et al., [15]	2007	138, India	3 cm	0.92	84.9%	90.6%	3	0.65	NR	NR
Aggarwal K and Yadav A [14]	2019	300, India	≤3.4 cm	0.72	82%	87%	2	0.93	95%	93%
Elghorori MR et al., [1]	2006	104, UK	≤3.4 cm	0.84	62%	100%	>3	0.5	23%	88%
Abdullah ZH et al., [19]	2022	294, Malaysia	≤2.7 cm	0.67	69.1%	60.9%	≥4	0.64	67.1%	55.2%
Ransiri PA et al., [20]	2018	392, Sri Lanka	≤3.3 cm	0.45	74.3%	43.7%	>3	0.59	76%	44.8%
Athulathmudali SR et al., [18]	2021	100, Sri Lanka	≤3.7 cm	0.83	88%	74%	>4.5	0.39	62%	50%
Present study	2022	124, India	≤3.6 cm	0.92	99.1%	79.5%	>2	0.93	98.13%	82.35%

[Table/Fig-14]: Comparing USG cervical length with modified BISHOP score [1,14,15,18-20].

be a better predictive value for successful labour induction [22]. But, in multiple regression analysis, it was not statistically significant.

So, if all three USG parameters are combined, they act as a better method in predicting successful induction as compared to the Modified Bishop score.

Limitation(s)

The present study includes only a population from a single medical centre and may not depict the rest of the population. Also, a single method of induction was used, different methods have different outcomes and labour duration. Authors did not include other sonographic parameters of the cervix such as the presence of wedging and distance of presenting part to external os, which may have additional value in predicting successful induction of labour. Further study in the future is needed to investigate the ultrasound parameter in predicting labour induction.

CONCLUSION(S)

Combining all the TVS parameters is more sensitive and specific than Modified Bishop in preinduction cervical assessment, hence can be used as an alternative in predicting successful labour induction.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
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