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Predictive Value of Transvaginal Ultrasonographic Cervical Assessment versus Bishop Score in Induction of Labour: A Comparative Cross-sectional Study

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Abstract

Background: *Induction of labour (IOL) is one of the most frequently performed obstetric interventions. Accurate prediction of induction success is crucial to minimize failed inductions and unnecessary caesarean sections. The Bishop score, though widely used, is subjective and has limited reproducibility. Transvaginal ultrasonography (TVS) offers an objective method for assessing cervical readiness.*

Objective: *To compare the predictive accuracy of transvaginal ultrasonographic cervical assessment using the Manipal Cervical Scoring System with the Modified Bishop Score in determining the success of induction of labour, and to analyse the influence of parity on induction outcomes.*

Methods: *This cross-sectional observational study included 89 term pregnant women (37–42 weeks) undergoing labour induction at a tertiary hospital. Pre-induction cervical assessment was performed by both TVS and digital examination by independent, blinded observers. Induction was carried out using intracervical prostaglandin E_2 with oxytocin augmentation as needed. The predictive value of each scoring system was evaluated by receiver operating characteristic (ROC) analysis, and independent predictors of successful induction were identified using binary logistic regression.*

Results: *Of the participants, 67.4 % entered active labour within 24 hours, and 56.2 % delivered vaginally. TVS score demonstrated superior predictive accuracy (AUC = 0.983, specificity = 100 %) compared with the Bishop score (AUC = 0.896, specificity = 89.7 %). Among TVS parameters, funnel length (OR = 16.98, p = 0.01) and cervical length (OR = 4.33, p = 0.01) were the most significant predictors, while cervical position was the only Bishop component significantly associated with active labour (p = 0.009). Multiparous women had shorter induction-to-delivery intervals (p = 0.007*) and higher vaginal delivery rates.*

Conclusion: *The Manipal TVS cervical score provides a superior, objective, and reproducible tool for predicting the outcome of labour induction compared with the Bishop score. Integration of TVS cervical assessment into pre-induction protocols can improve patient selection and reduce unnecessary caesarean deliveries.*

Key words: *Transvaginal Ultrasonography, Cervical Length, Bishop Score, Labour Induction, Funnel Length, Cervical Assessment, Ultrasound Scoring, Parity, Obstetric Ultrasound*

1. INTRODUCTION

Induction of labour (IOL) is among the most frequently performed obstetric interventions worldwide, accounting for nearly one-fifth of all deliveries (1–3). It is performed when continuation of pregnancy poses greater risks than delivery. The success of induction depends largely on the pre-induction cervical status; hence, accurate evaluation of cervical ripening is central to obstetric decision-making (4,5).

Since its introduction by Bishop in 1964 (6), the Bishop score has remained the most widely accepted clinical tool for assessing cervical favourability before IOL. However, despite its simplicity, the score has major limitations — it is subjective, prone to inter- and intra-observer variation, and evaluates only the vaginally accessible segment of the cervix (7,8). Digital palpation cannot assess the supravaginal portion or quantify effacement accurately, and its reproducibility across examiners is limited (9).

Technological advances have enabled transvaginal ultrasonography (TVS) to emerge as a reliable, objective alternative for evaluating cervical characteristics (10–12). TVS provides quantitative measurements of cervical length, funnel configuration, internal-os morphology, and distance of the presenting part, allowing full visualisation of the cervical canal with minimal patient discomfort. Among these parameters, cervical length has consistently shown a strong correlation with both spontaneous and induced labour outcomes (13,14).

Several studies have demonstrated that shorter cervical length and the presence of funnelling predict higher rates of successful vaginal delivery after induction (15–17). Conversely, some authors report similar predictive accuracy between TVS and Bishop scoring, underscoring the need for further comparative validation (18,19).
To standardise sonographic evaluation, the Manipal Cervical Scoring System was proposed — a composite TVS-based scale combining five ultrasonographic parameters: cervical length, funnel length, funnel width, cervical position, and distance from the presenting part to the external os (20). Initial studies demonstrated superior sensitivity, specificity, and area under the receiver-operating characteristic curve (AUC) compared with Bishop scoring (21,22). Nonetheless, data remain scarce, particularly from low- and middle-income settings where obstetric practices and population profiles differ substantially (23).
Failed induction remains a major contributor to primary caesarean section (CS) rates worldwide, accounting for up to 20 % of procedures in several reports (24,25). Reducing unnecessary CS deliveries through better prediction of IOL outcomes is therefore an essential goal in contemporary obstetrics (26). A precise and reproducible pre-induction assessment can guide clinicians in selecting the most appropriate method and timing of induction, improving patient counselling, and optimising maternal–fetal outcomes (27–29).

Study Aim and Objectives

Given the persisting uncertainty regarding the predictive superiority of ultrasonographic assessment over digital scoring, this study was undertaken with the following specific objectives:
1. To compare pre-induction transvaginal ultrasonographic (TVS) cervical assessment using the Manipal Cervical Scoring System with the Modified Bishop Score in predicting the success of labour induction.
2. To determine the relationship between parity, pre-induction cervical length, induction-to-delivery interval, and rate of vaginal delivery within 24 hours of induction.
3. To evaluate which specific sonographic and clinical parameters serve as the most significant independent predictors of successful induction.
Through this comparison, the study seeks to establish whether the TVS cervical score can provide a more objective, reproducible, and clinically implementable alternative to the Bishop score for predicting induction outcomes in term pregnancies (30).

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was a cross-sectional observational study conducted between *January 2021 and June 2022* in the Department of Obstetrics and Gynaecology, Vydehi Institute of Medical Sciences and Research Centre, Bengaluru, India, a tertiary-care teaching hospital serving both urban and semi-rural populations (10, 11). Ethical approval was obtained from the Institutional Ethics Committee (IEC/VIMS/OBG/2021/07), and all participants provided written informed consent (12).

2.2 Participants

Eighty-nine pregnant women admitted for planned induction of labour (IOL) were recruited consecutively.
Inclusion criteria — singleton live pregnancy, gestational age 37–42 weeks confirmed by first-trimester ultrasound, cephalic presentation, longitudinal lie, intact membranes, and reassuring fetal heart rate tracing.
Exclusion criteria — previous caesarean or uterine surgery, placenta praevia or antepartum haemorrhage, cephalopelvic disproportion, malpresentation, multiple gestation, or major fetal anomaly (13).

2.3 Sample-Size Determination

The sample size was estimated from the expected specificity of TVS scoring using the binomial approximation:

$$n = \frac{Z_{1-\alpha/2}^2 Sp(1-Sp)}{d^2(1-P)}$$

where
$Z_{1-\alpha/2} = 1.96$ (for 95% confidence),
$Sp = 0.758$ (expected specificity 75.8%),
$d = 0.10$ (absolute precision 10%), and
$P = 0.20$ (expected prevalence 20%).
Substituting yields $n \approx 89$, which was adopted as the final sample (14).

2.4 Pre-Induction Cervical Assessment

2.4.1 Transvaginal Ultrasonography (TVS)

Each participant underwent **TVS** on a *Philips HD 7 XE* scanner using a 5–7 MHz endovaginal probe. Scans were performed with the bladder emptied and the probe positioned in the anterior fornix to obtain a mid-

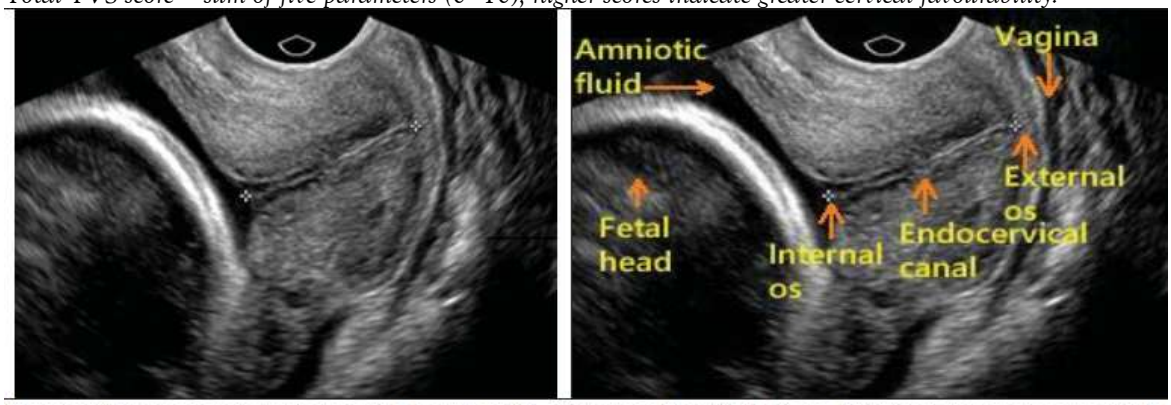
sagittal image of the cervix showing both internal and external os. Minimal pressure was applied to prevent artificial elongation (15, 16).

The Manipal Cervical Scoring System quantified five sonographic parameters—cervical length, funnel length, funnel width, cervical position, and distance from the presenting part to the external os (17). Three readings were recorded and averaged. The examiner performing TVS was blinded to digital findings.

Table 1. Manipal Transvaginal Cervical Scoring System

Parameter	Score 0	Score 1	Score 2
Cervical length	> 3 cm	2–3 cm	< 1 cm
Funnel length	Absent	≤ 0.5 cm	> 0.5 cm
Funnel width	Absent	≤ 0.5 cm	> 0.5 cm
Cervical position	Curved	Midway	Straight
Distance of presenting part to external os	> 3 cm	2–3 cm	< 2 cm

Total TVS score = sum of five parameters (0–10); higher scores indicate greater cervical favourability.



Normal Transvaginal Cervical Length with a Proper Sagittal View, Distinct Appearance of the Distal Cervix, and Proper Placement of the Cursors for Measurement.

Figure 1. Representative Transvaginal Ultrasound Images

2.4.2 Digital Cervical Assessment (Modified Bishop Score)

Immediately after TVS, a second examiner—blinded to ultrasound results—performed a digital cervical examination and assigned a Modified Bishop Score based on dilatation, effacement, consistency, position, and fetal-head station (18, 19). Scores ≤ 4 were considered unfavourable, 5–8 intermediate, and ≥ 9 favourable (20).

Table 2. Modified Bishop Scoring System

Parameter	0	1	2	3
Dilatation (cm)	Closed	1–2	3–4	≥ 5
Effacement (%)	0–30	40–50	60–70	> 80
Station	−3	−2	−1	+1 / +2
Consistency	Firm	Medium	Soft	—
Position	Posterior	Mid	Anterior	—

2.5 Induction Protocol

Labour induction was initiated within 12 hours of cervical assessment using intracervical prostaglandin E_2 (PGE_2) gel 0.5 mg, repeated every 6 hours to a maximum of three doses. Oxytocin augmentation followed cervical ripening or rupture of membranes, and artificial rupture was performed when indicated. Continuous fetal monitoring was maintained throughout (21).

- Successful induction = active labour (≥ 4 cm dilatation) within 24 h with vaginal delivery.
- Failed induction = no active labour within 24 h or caesarean for non-progress or fetal distress.

2.6 Outcome Variables

Primary Outcome: successful induction (active labour ≤ 24 h).

Secondary Outcomes: induction-to-delivery interval (hours) and mode of delivery (vaginal/caesarean).

Predictor Variables: individual and composite TVS and Bishop scores and parity (22).

2.7 Statistical Analysis

All data were analysed using IBM SPSS Statistics v19. Continuous variables are expressed as *mean ± SD* and categorical variables as *frequency (%)*. Normality was tested by the Kolmogorov–Smirnov method. Associations between categorical variables were evaluated using the Chi-square test. Diagnostic accuracy of each scoring

system was assessed with Receiver Operating Characteristic (ROC) analysis to compute the area under the curve (AUC), sensitivity, specificity, and likelihood ratios. Binary logistic regression identified independent predictors of successful induction, reported as odds ratios (OR) with 95 % confidence intervals. A two-tailed $p < 0.05$ was considered statistically significant (23–25). All reporting adhered to the STROBE guidelines for observational research (26–30).

3. RESULTS

3.1 Participant Characteristics

Eighty-nine women who fulfilled the inclusion criteria were analysed. The mean ± SD age was 25.7 ± 4.2 years (range = 19–33 years). Most were primigravidae (52.8 %) with a gestational age of 37–40 weeks (63 %) at induction.

Half of the participants (49 %) had a normal BMI (18.5–24.9 kg/m²). The most frequent indication for induction was post-dated pregnancy (36 %), followed by gestational diabetes (20 %), preeclampsia (14 %), and IUGR / oligohydramnios (17 %).

Table 3. Baseline characteristics of the study population (n = 89)

Variable	Category	n (%)
Age (years)	< 25	42 (47.2)
	26–30	38 (42.7)
	> 30	9 (10.1)
Gravidity	Primigravida	47 (52.8)
	Multigravida	42 (47.2)
BMI (kg/m²)	18.5–24.9	44 (49.4)
	25–29.9	37 (41.6)
	≥ 30	5 (5.6)
Gestational age (weeks)	37–40	56 (62.9)
	> 40	33 (37.1)
Primary indication for induction	Post-dated pregnancy	32 (36.0)
	GDM	18 (20.2)
	Preeclampsia	12 (13.5)
	IUGR / Oligohydramnios	15 (16.9)
	PROM / Others	12 (13.4)

3.2 Mode of Delivery and Labour Outcome

Of the 89 participants, 60 (67.4 %) entered active labour within 24 hours of induction. Fifty (56.2 %) achieved full-term normal vaginal delivery, whereas 36 (40.4 %) underwent emergency caesarean section, most commonly for failed induction (75 %) or fetal distress (17 %). The mean induction-to-delivery interval was 13.7 ± 4.1 hours, significantly shorter among multiparous women ($p = 0.007$).

3.3 Comparison of TVS and Bishop Scores

Both the transvaginal-ultrasound (TVS) and Bishop scores correlated positively with induction success, but TVS showed higher predictive accuracy.

- Mean TVS score (successful vs failed induction): 5.9 ± 1.4 vs 3.1 ± 1.0, $p < 0.001$
- Mean Bishop score (successful vs failed induction): 5.2 ± 1.1 vs 3.7 ± 1.3, $p < 0.01$

Table 4. Diagnostic accuracy of TVS and Bishop scores for predicting active labour

Cut-off score	Sensitivity (%)	Specificity (%)	Positive LR	Negative LR	AUC (95 % CI)	p -value
TVS ≥ 2	91.7	100	9.9	0.08	0.983 (0.96–1.00)	< 0.001
TVS ≥ 3	81.7	100	8.0	0.18	—	—
TVS ≥ 4	51.7	100	7.6	0.48	—	—
Bishop ≥ 2	96.7	51.7	2.0	0.06	0.896 (0.82–0.97)	< 0.001
Bishop ≥ 3	86.7	72.4	3.1	0.18	—	—
Bishop ≥ 4	71.7	89.7	7.0	0.32	—	—

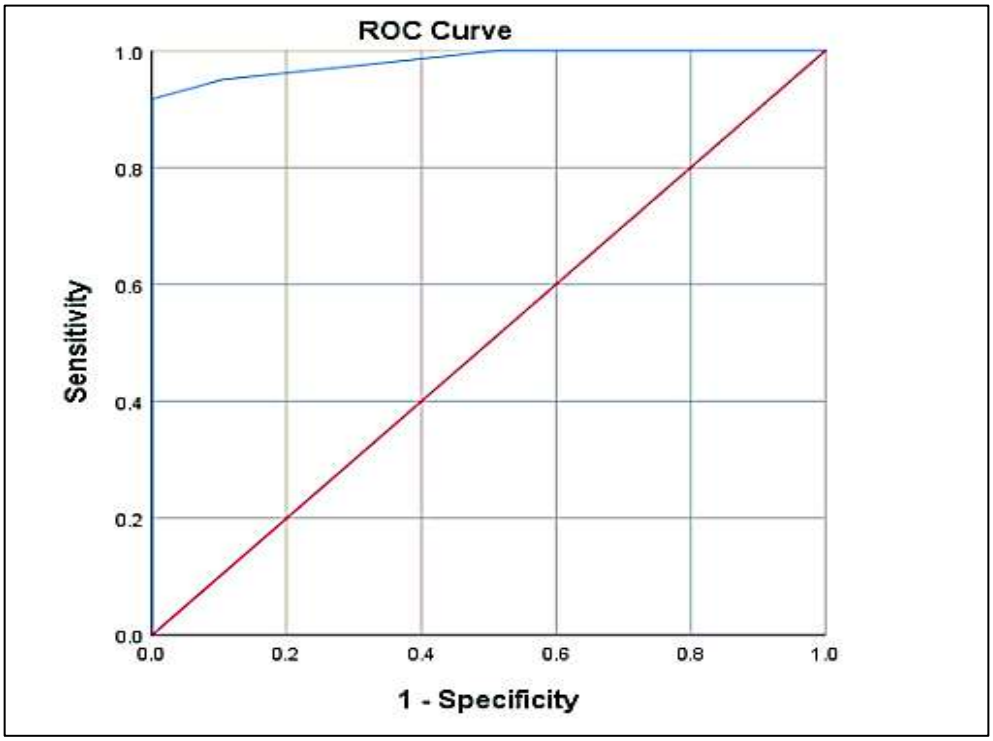


Figure 2. Receiver-operating-characteristic (ROC) curve for TVS score
TVS score ≥ 4 yielded AUC 0.983 with 100 % specificity and p < 0.001.

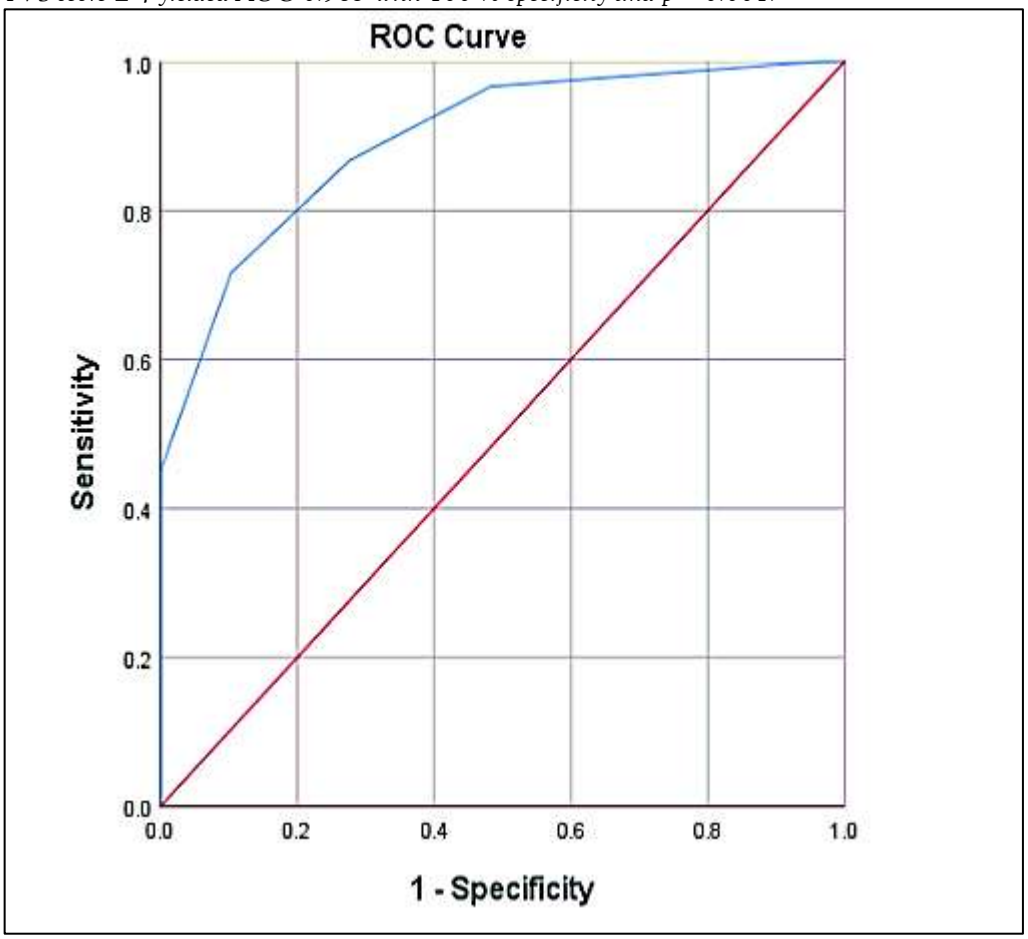


Figure 3. Receiver-operating-characteristic (ROC) curve for Bishop score

Bishop score ≥ 4 yielded AUC 0.896 with 89.7 % specificity and p < 0.001.

3.4 Independent Predictors of Successful Induction

Binary logistic regression identified funnel length and cervical length on TVS, and cervical position from the Bishop score, as independent predictors of active labour within 24 hours.

Table 5. Independent predictors of successful induction (logistic regression)

Predictor	β (± SE)	OR	95 % CI	p -value
Funnel length (TVS)	2.83 (1.85)	16.98	1.23 – 640.39	0.01
Cervical length (TVS)	1.47 (1.03)	4.33	1.57 – 32.79	0.01
Funnel width (TVS)	1.17 (1.69)	3.21	0.12 – 88.28	0.49
Cervical position (Bishop)	1.57 (0.60)	4.81	1.48 – 15.64	0.009
Constant	−2.61 (0.90)	0.07	—	0.004

3.5 Parity and Delivery Outcomes

Parity was not significantly associated with pre-induction cervical length ($p = 0.97$), but multiparous women had a shorter induction-to-delivery interval and a higher rate of vaginal delivery than nulliparous women.

Table 6. Parity and induction-to-delivery interval

Parity	8–12 h n (%)	13–16 h n (%)	17–24 h n (%)
Nulliparous (n = 47)	13 (27.7)	16 (34.0)	18 (38.3)
Multiparous (n = 42)	25 (59.5)	10 (23.8)	7 (16.7)
$p = 0.007$			

Table 7. Parity and mode of delivery

Parity	Vaginal n (%)	Caesarean n (%)
Nulliparous (n = 47)	22 (46.8)	25 (53.2)
Multiparous (n = 42)	31 (73.8)	11 (26.2)

3.6 Neonatal Outcomes

All neonates were live-born. The mean birth weight was 2.9 ± 0.4 kg, and all had Apgar ≥ 7 at 5 minutes. Six infants (6.7 %) required short-term NICU admission for transient respiratory distress; no perinatal deaths occurred.

4. DISCUSSION

The present study demonstrates that transvaginal ultrasonographic (TVS) assessment of the cervix, as quantified by the Manipal Cervical Scoring System, is a superior and more objective method for predicting the success of labour induction than the traditional Bishop score. Successful induction was achieved in two-thirds of participants, with the majority delivering vaginally. The high predictive performance of the TVS score (AUC = 0.983, specificity = 100 %) compared with the Bishop score (AUC = 0.896, specificity = 89.7 %) underscores the clinical value of ultrasonographic parameters in cervical assessment. These findings reinforce the notion that the mechanical and morphological features of the cervix—particularly cervical length and funnel configuration—are critical determinants of the induction response, a concept previously proposed by several authors using both qualitative and quantitative sonographic analyses.

The present results align with the work of Bajpai and colleagues, who established the Manipal scoring system and reported that TVS-derived cervical parameters more accurately predicted induction outcomes than Bishop scoring. Similar trends have been observed in other contemporary series, including those by Agrawal, Vince, and Kim, who confirmed the diagnostic superiority of ultrasonographic measures, particularly cervical length and funnelling, across varied populations and induction protocols. Conversely, a few studies, notably those by Chandra and Pandis, found comparable predictive value between digital and sonographic scoring. Such discrepancies likely reflect methodological heterogeneity, interobserver variation, and differences in defining successful induction across studies.

In this study, multivariate analysis identified funnel length and cervical length as independent predictors of active labour within 24 hours, consistent with the biomechanical understanding that progressive collagen disorganization and shortening of the endocervical canal signal advanced cervical ripening. The ability of TVS to visualise the supravaginal portion of the cervix—unreachable by digital examination—provides an anatomic and physiologic advantage that likely accounts for its higher predictive accuracy. Among the clinical parameters, cervical position was the only Bishop component that retained significance, supporting previous observations that anterior orientation of the cervix is associated with increased readiness for labour.

Parity influenced both the induction-to-delivery interval and mode of delivery, with multiparous women showing shorter labour durations and higher vaginal-delivery rates, reflecting established obstetric patterns of cervical compliance and uterine contractility. However, no significant association was found between parity and pre-induction cervical length, suggesting that the structural dimensions of the cervix at term are relatively independent of parity, whereas functional responsiveness differs.

The clinical implications of these findings are substantial. As failed induction remains a major contributor to primary caesarean sections worldwide, the integration of TVS-based cervical scoring could enable better stratification of candidates for induction, improved counselling, and rational selection of ripening agents. In settings where ultrasonography is routinely available, the Manipal score offers a reproducible and patient-friendly alternative that reduces subjective variability inherent in digital scoring. Moreover, the visual and measurable data from TVS can be archived for longitudinal monitoring and medico-legal documentation—advantages particularly valuable in tertiary-care and research environments.

Nevertheless, the results should be interpreted in light of certain limitations. The study sample was relatively small and limited to a single centre, potentially affecting generalizability. Although blinding was maintained between sonographic and digital examiners, some degree of operator dependence in image acquisition and interpretation is unavoidable. Future multicentric studies with larger and more diverse cohorts, inclusion of additional sonographic parameters such as posterior cervical angle or cervical elastography, and assessment of interobserver reproducibility would help refine the predictive algorithms further.

In summary, transvaginal ultrasonographic cervical assessment provides a quantitative, objective, and reproducible method for predicting the outcome of labour induction. The Manipal TVS score, by integrating key anatomic and positional variables, surpasses the Bishop score in diagnostic precision and clinical utility. Incorporating TVS into pre-induction protocols may reduce induction failures, optimize obstetric decision-making, and ultimately contribute to lowering unnecessary caesarean deliveries while maintaining maternal and neonatal safety.

5. CONCLUSION

This study demonstrates that transvaginal ultrasonographic (TVS) cervical assessment, quantified through the Manipal Cervical Scoring System, is a more accurate and objective method for predicting successful induction of labour than the conventional Bishop score. The parameters of funnel length and cervical length emerged as the strongest independent predictors of induction success, while cervical position remained the most relevant clinical variable.

The findings confirm that ultrasonographic assessment offers superior reproducibility, eliminates observer bias, and provides measurable criteria that can be integrated into routine obstetric practice. Incorporating TVS scoring before induction may improve patient selection, reduce failed inductions, and ultimately lower unnecessary caesarean section rates. Future multicentric studies using larger cohorts and advanced sonographic modalities such as cervical elastography are warranted to validate these results and establish standardized ultrasound-based predictive models for labour induction.

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