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Original Research Article

AN OBSERVATIONAL STUDY TO DETERMINE EFFICACY OF LEVINE VALIDATED CALCULATOR IN PREDICTION OF LSCS AFTER INDUCTION OF LABOUR IN TERTIARY CARE CENTRE IN SOUTH GUJARAT

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ABSTRACT

Background: Induction of labour (IOL) in term pregnancies with an unfavourable cervix is often associated with increased caesarean section rates. Accurate prediction of lower segment caesarean section (LSCS) can guide clinical decisions, enhance patient counselling, and improve outcomes. The Levine validated calculator estimates LSCS probability based on clinical parameters, but its utility in Indian populations is not well established. The objective is to assess the predictive accuracy of the Levine calculator for LSCS in term pregnant women undergoing IOL in a tertiary care setting. **Materials and Methods:** This prospective observational study included 120 term pregnant women (≥37 weeks) with singleton, cephalic fetuses, intact membranes, and a Bishop score ≤6 with cervical dilatation ≤2 cm, undergoing IOL at a tertiary hospital. The Levine calculator score was recorded at admission. Participants were monitored per institutional protocol, and mode of delivery was documented. Associations between maternal characteristics, Levine scores, and LSCS outcomes were statistically analysed. **Result:** Of the 120 participants, 70 (58.3%) were nulliparous. The leading indications for IOL were postdatism (42.5%) and oligohydramnios (21.7%). Vaginal delivery was achieved in 88 women (73.33%), while 32 (26.67%) required LSCS. Significant associations were found between LSCS and Levine score >30% ($p<0.001$), nulliparity ($p=0.012$), BMI >30 kg/m² ($p=0.03$), and cervical dilatation <1 cm ($p=0.001$). The Levine calculator demonstrated good concordance between predicted and actual outcomes, particularly in high-risk groups. **Conclusion:** The Levine calculator is an effective tool for predicting LSCS following IOL in women with unfavourable cervices. Its application may enhance individualized care and resource planning in obstetric practice.

INTRODUCTION

The rising incidence of caesarean deliveries, particularly lower segment caesarean sections (LSCS) following induction of labour, is a growing concern in obstetric care worldwide. While labour induction is a common and often necessary obstetric intervention performed to prevent adverse maternal and fetal outcomes, it does not guarantee a successful vaginal delivery.[1]

Despite being one of the most frequently performed procedures in obstetrics, our ability to accurately predict the outcome of labour induction remains limited. Given the potential risks associated with prolonged labour and failed induction—including infection, uterine rupture, fetal distress, and unnecessary operative delivery—there is a strong clinical need for reliable tools that can accurately estimate the likelihood of LSCS after labour induction.[2]

The Levine validated calculator is one such predictive model that has been developed to estimate the probability of caesarean delivery after labour induction using a combination of maternal demographic and obstetric parameters. The calculator has shown promising results in Western

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populations, providing clinicians with a personalized risk assessment to guide decisions regarding labour induction.[3]

However, the external applicability and predictive efficacy of the Levine validated calculator in varied demographic and clinical settings, such as the Indian population, particularly in South Gujarat, remain uncertain. This observational study seeks to evaluate the efficacy of the Levine validated calculator in predicting LSCS following labour induction at a tertiary care centre in South Gujarat. By doing so, the study hopes to inform evidence-based obstetric practices and promote individualized care in the management of labour induction.[4]

MATERIALS AND METHODS

This prospective observational study was done in OBGYN department of NCHS after official approval from ethics committee.

Total 120 consenting women fulfilling inclusion criteria admitted in labour room undergoing induction of labour for various obstetric indications with unfavorable cervix were enrolled in the study.

Full term (more than 37 weeks of gestation) women carrying singleton gestation with intact membranes and an unfavorable cervix (Bishop score less than or equal to 6, dilatation less than or equal to 2cms) undergoing induction of labour will be included in the study.

A validated (Levine) calculator will be applied to predict the risk of LSCS after induction.

Inclusion Criteria

All consenting pregnant women delivering after induction of labour at or beyond term ≥37 weeks with single live fetus with cephalic presentation with intact membrane with unfavorable cervix (bishop score ≤6 and dilatation ≤2 cms).

Exclusion Criteria

- Women with spontaneous onset of labour.
- Women undergoing induction of labour with preterm labour, multiple pregnancy, fetal anomaly, intrauterine fetal death, with favorable cervix, PROM.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic and clinical characteristics, with frequencies and percentages for categorical variables and means with standard deviations for continuous variables.

Associations between categorical variables (e.g., BMI category, Bishop score, parity, predicted risk group) and mode of delivery (vaginal vs. LSCS) were analyzed using the Chi-square test. The Independent Samples t-test was used to compare the mean age between the two delivery groups.

A p-value of less than 0.05 was considered statistically significant. All analyses were two-tailed.

RESULTS & DISCUSSION

Table 1: Socio-Demographic Characteristics

Age	No. of subjects (n=120)	Percentage
<19 yrs	14	11.67%
20-29 yrs	92	76.67%
30-39 yrs	14	11.66%
Residence		
Urban	103	85.83%
Rural	17	14.17%
Parity		
Nullipara	70	58.33%
Primipara	29	24.17%
Multipara	21	17.50%
BMI (kg/m2)		
18.5-24.9	67	55.83%
25-29.9	37	30.83%
>30	16	13.34%

Among the 120 participants, the majority were between 20 and 29 years of age, comprising 76.67% of the study subjects. Participants younger than 19 years and those aged 30–39 years each made up 11.67% of the study population.

The mean age among the study subject was 24.13 years. Youngest being 19 years while oldest being 38 years of age.

Out of the total subjects, 85.83% resided in urban areas, while 14.17% were from rural areas, indicating a predominantly urban study population.

In present study, 58.33% of the women were nulliparous, 24.17% were primiparous, and 17.50% were multiparous.

Among the 120 subjects, the majority (55.83%) had a BMI within the normal range (18.5–24.9), total 67 individuals. A significant portion, 37 subjects (30.83%), were classified as overweight (BMI 25–29.9). Additionally, 16 women were classified as obese (>30).

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Table 2: Details on admission in labour room

Gestational Age	Number of subjects(n=120)	Percentage
37-37+6 WK	19	15.83%
38-38+6WK	20	16.67%
39-39+6WK	24	20.00%
40-40+6WK	50	41.67%
41-41+6WK	5	4.17%
>42WK	2	1.67%
Cervical dilation (in cm)		
<1	10	8.33%
1-2.5	110	91.67%
Cervical Effacement		
0-30%	78	65.00%
40-50%	42	35.00%
Modified bishop score		
<3	12	10.00%
4	28	23.33%
5	36	30.00%
6	44	36.67%
Induction done with		
M+C (Mechanical + Cerviprime)	111	92.50%
C (Cerviprime)	9	7.50%
Outcome of induction		
Successful induction	88	73.33%
Failed induction	7	5.83%
Incomplete attempt	25	20.83%

Out of 120 subjects, the highest proportion (41.67%) were admitted at a gestational age of 40 to 40+6 weeks. This was followed by 20.00% admitted at 39 to 39+6 weeks, 16.67% at 38 to 38+6 weeks, and 15.83% at 37 to 37+6 weeks. A small proportion were admitted at 41 to 41+6 weeks (4.17%) and beyond 42 weeks (1.67%).

At the time of admission, 91.67% of the subjects had a cervical dilation between 1 to 2.5 cm, while 8.33% had less than 1 cm dilation.

Out of 120 subjects, the majority (65.00%) presented with 0–30% cervical effacement at the time of admission, accounting for 78 individuals. The remaining 42 subjects (35.00%) had 40–50% effacement. This indicates that most participants were in the early stage of cervical effacement upon admission.

The majority of participants had a modified Bishop score of 6 (36.67%), followed by 30% with a score of 5, 23.33% with a score of 4, and 10% with scores below 3.

The combined method of mechanical and cerviprime (M+C) induction was used in the majority of cases (92.5%), while only 7.5% underwent pharmacological (cerviprime) induction alone.

Most participants (46.67%) required only one induction attempt. Two attempts were needed in 35% of cases, and 18.33% required three attempts.

Out of 120 subjects, 88 individuals (73.33%) had a successful induction, indicating that the majority responded well to induction methods and progressed to active labor. 25 subjects (20.83%) had an incomplete attempt, meaning the induction process was initiated but not fully carried through or completed.

A smaller proportion, 7 subjects (5.83%), experienced a failed induction, where the induction did not lead to the progress of labour.

Maternal and fetal outcome

Out of the 120 subjects, the majority 88 individuals (73.33%) had a vaginal delivery. A smaller portion, 32 subjects (26.67%), had a caesarean section (LSCS).

Among the 32 caesarean deliveries, 90.62% fell under Robson Class 2 (nulliparous with induced labor), while 9.38% were classified under Class 4 (multiparous with induced labor).

Among 32 subjects, the common indication was fetal distress, and meconium-stained liquor (MSL) observed in 12 subjects (37.50%) each. Failure of induction accounted for 7 subjects (21.88%). A combination of fetal distress and MSL was noted in 1 subject (3.12%).

Postpartum complications were observed in 8 cases. The most common was puerperal pyrexia (37.5%), followed by postpartum hemorrhage (25%), puerperal sepsis (12.5%), postpartum eclampsia (12.5%), and wound infection (LSCS scar dehiscence) (12.5%).

A total of 13 newborns (10.83%) required NICU admission, while the remaining 10 (89.17%) did not need NICU admission.

Among the 13 NICU admissions, the most common reason was Meconium-stained liquor (MSL), observed in 46.16% of newborn. Other causes included Transient tachypnoea of the newborn (TTN), neonatal jaundice, and low birth weight (each accounting for 15.38%). Birth asphyxia was responsible for one admission (7.7%).

Out of 120 neonates, 10 neonates (8.33%) required respiratory support, while the remaining 110

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neonates (91.67%) did not require any respiratory support.

The overall neonatal outcome was favourable, with 99.17% of the babies discharged. There was one neonatal death, accounting for 0.83% of the total births which was due to Meconium aspiration syndrome with Neonatal sepsis on 3rd post-natal day.

Table 3: Levine Calculator

Probability of caesarean section acc. to Levine calculator	No. of subjects (n=120)	Percentage
<5%	3	2.50%
5-10%	27	22.50%
10-20%	29	24.17%
20-30%	30	25.00%
30-40%	18	15.00%
40-50%	7	5.83%
>50%	6	5.00%

Among the 120 subjects, 30 individuals (25.00%), had a probability of caesarean section in the 20-30% range. 29 subjects (24.17%) had a probability in the 10-20% range, and 27 individuals (22.50%) lies within the 5-10% range.

Smaller groups were observed in higher probability ranges: 18 individuals (15.00%) had a probability between 30-40%, while 7 subjects (5.83%) had a probability between 40-50%. 6 individuals (5.00%) had a probability of caesarean section greater than 50%. Only 3 individuals (2.50%) had a probability of less than 5%.

Table 4

Probability of cesarean section	Mode of delivery		Chi square	p-value
	Vaginal Delivery	LSCS		
<5%	3(100.0)	0(0.0)	80.762	0.001
5-10%	27(100.0)	0(0.0)		
10-20%	27(93.1)	2(6.9)		
20-30%	27(90.0)	3(10.0)		
30-40%	4(22.2)	14(77.8)		
40-50%	0(0.0)	7(100.0)		
>50%	0(0.0)	6(100.0)		

A chi-square test was used to explore the association between the predicted probability of caesarean delivery and the actual mode of delivery. In the groups with predicted probabilities of less than 30%, the majority of women delivered vaginally, with rates ranging from 90.0% to 100.0%. Specifically, in the <5% and 5–10% categories, all deliveries were vaginal. In contrast, higher predicted probabilities were associated with a greater proportion of LSCS. In the 30–40% group, 77.8% underwent LSCS, while in both the 40–50% and >50% groups, all women had LSCS. The chi-square value was 80.762 with a p-value of 0.001, indicating a highly significant association between the predicted probability of caesarean delivery and the actual mode of delivery.

Among those with a predicted risk <30%, most delivered vaginally. Higher predicted risk groups (30–50% and >50%) showed a greater proportion of LSCS.

Table 5

Levine calculator parameters		Mode of delivery		Chi square	p-value
		Vaginal delivery (%)	LSCS (%)		
Maternal Height (in inches)	<62	71(71.0)	29(29.0)	2.352	0.503
	62-63.9	14(87.5)	2(12.5)		
	64-65.9	2(66.7)	1(33.3)		
	>66	1(100.0)	0(0.0)		
BMI	Normal	59(92.2)	5(7.8)	25.204	0.001
	Overweight	22(53.7)	19(46.3)		
	Obese	7(46.7)	8(53.3)		
Nulliparous	Yes	41(58.57)	29(41.43)	17.874	0.001
	No	47(94)	3(6)		
Modified bishops score	<3	5(41.7)	7(58.3)	10.035	0.018
	4	27(75.0)	9(25.0)		
	5	31(70.5)	13(29.5)		
	6	25(89.3)	3(10.7)		
Gestational age at induction ≥ 40 weeks	Yes	40(70.17)	17(29.83)	0.731	0.392
	No	48(76.19)	15(23.81)		

Among women with a maternal height less than 62 inches, 71 (71.0%) had a vaginal delivery, while 29 (29.0%) underwent a caesarean section (LSCS). Among those with a height between 62 and 63.9 inches, 12 out of 14 women (87.5%) delivered vaginally, and 2 (12.5%) had an LSCS. In the 64–65.9 inch height group, 2 women (66.7%) had a vaginal delivery, and 1 (33.3%) underwent an LSCS. The group with a height above 66 inches included only one woman, who had a vaginal delivery (100%). A p-value of 0.503 indicates that the association between maternal height and mode of delivery is not statistically significant.

A strong and statistically significant association was found between BMI and mode of delivery (p=0.001). Women with normal BMI had the highest rate of vaginal deliveries (92.2%) and the lowest LSCS rate (7.8%). In contrast, overweight women had a significantly lower rate of vaginal deliveries (53.7%) and higher LSCS rate (46.3%). Among obese women, 46.7% had vaginal deliveries, while the LSCS rate was slightly higher at 53.3%, indicating increasing LSCS likelihood with higher BMI.

Parity was significantly associated with the mode of delivery (p=0.001). Among nulliparous women, 58.57% delivered vaginally while 41.43% underwent LSCS. In contrast, 94% of multiparous women had vaginal deliveries, and only 6% required LSCS. This study suggest that nulliparity is linked to a higher probability of caesarean delivery.

The modified Bishop's score also showed a significant association with the mode of delivery (p=0.018). Women with a score less than 3 had the highest LSCS rate (58.3%), whereas those with scores of 4 and 5 had vaginal delivery rates of 75.0% and 70.5%, respectively. A score of 6 was associated

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with the highest vaginal delivery rate (89.3%) and the lowest LSCS rate (10.7%).

Table 6

Study	Maternal Height (p-value)	BMI (p-value/AUC)	Nulliparous (p-value)	Modified Bishop's Score (p-value/AUC)	Gestational Age (p-value)
Present study (2025)	0.503	0.001	0.001	0.018	0.392
Reddy et al. (2017) (N=10,591)	<0.001	–	<0.001	–	<0.001
Sun F et al. (2022) (N=491)	<0.001	<0.001	0.77(AUC)	–	<0.001
Vahratian et al. (2005) (N=2057)	-	–	–	–	<0.001
Levine et al. (2018) (N=6636)	0.05	0.005	<0.001	0.006	<0.001

No significant association was found between gestational age at induction and mode of delivery (p=0.392). Among those induced after 40 weeks, 70.17% had vaginal deliveries and 29.83% had LSCS. In comparison, those induced before or at 40 weeks had a slightly higher vaginal delivery rate of 76.19% and a lower LSCS rate of 23.81%. However, these differences were statistically insignificant.

When comparing the present study's findings to previous research, several consistencies and differences were observed in the predictive significance of individual clinical parameters used in the Levine calculator.

In the current study, BMI, nulliparity, and modified Bishop score were found to be significantly associated with mode of delivery (p = 0.001, 0.001, and 0.018 respectively). These findings are consistent with previous studies, including Levine et al. (2018) and Sun et al. (2022), which also demonstrated statistical significance or high predictive value (AUC) for these parameters.[5,6]

Maternal height, which was not significantly associated with mode of delivery in the present study (p = 0.503), has been shown to be a significant predictor in larger datasets such as Reddy et al. (2017) and Sun et al. (2022). Similarly, gestational age at induction was not statistically significant in the present study (p = 0.392), although all prior studies, including Vahratian et al. (2005) and Levine et al. (2018), found strong associations (p < 0.001).[7,8]

Overall, the findings from this study align with the broader literature regarding the predictive value of BMI, parity, and Bishop score, while highlighting potential variability in the impact of maternal height and gestational age across different populations.

Overall, our findings validate the use of the Levine calculator as a helpful adjunct in predicting induction outcomes, particularly in women with an unfavorable cervix. However, the model may perform variably depending on population characteristics, suggesting the need for localized evaluation and possible recalibration of predictive thresholds. The significant correlation between calculator-predicted risk and actual delivery outcomes supports its integration into clinical counseling and decision-making, especially when discussing induction with patients and planning individualized care.

CONCLUSION

The present study concludes that the Levine validated calculator is a useful tool in predicting the likelihood of LSCS following induction of labour. It demonstrated a good predictive value, aiding clinicians in identifying patients at higher risk for LSCS. Its use can enhance patient counselling, support better clinical decision making and optimizing labour management.

The web- based novel tool can offer an evidence based approach to counselling women regarding the risk of caesarean when undergoing an induction with an unfavourable cervix. Future studies required to focus on the maternal and neonatal morbidity associated with a high predicted caesarean risk in order to further aid in patient counselling and decision making.

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