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A comparative study of pharmacological, nonpharmacological, and combined methods of induction of labor

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ABSTRACT

Introduction and aim. Induction of labor (IOL), a common obstetric procedure, aims to induce labor. The study defined labor induction success as true uterine contractions and classified delivery outcomes as vaginal, instrumental, and cesarean. A higher Bishop score predicts a vaginal delivery. The objective was to compare cervical status, induction success, cesarean section rates, and normal delivery rates of pharmacological and non-pharmacological IOL methods.

Material and methods. In this study, 296 pregnant women admitted to the labor room were divided into three groups: those who received pharmacological agents (25 μg/50 μg misoprostol or dinoprostone 5 g gel to start labor), those who were given non-pharmacological agents (Foley's catheter and membrane stripping to start labor), and those who were given both non-pharmacological and pharmacological agents (Foley's catheter and membrane stripping followed by oxytocin to start labor).

Results. Although a 92.5% induction success rate, the use of non-pharmacological methods alone led to a rate of 49.06% cesarean section rate. Combined with a pharmacological agent such as oxytocin, it achieved almost the same success rate (91.43%) as a pharmacological method of inducing labor (18.57%). This resulted in a lower rate of cesarean section than pharmacological and nonpharmacological methods ($p=0.002$).

Conclusion. Nonpharmacological IOL methods alone led to higher cesarean rates despite improved cervical status. Combining them with pharmacological agents such as oxytocin resulted in higher normal delivery rates and fewer cesarean sections, indicating a more effective approach for improving delivery outcomes.

Keywords. Bishop score, cervical ripening, cesarean section, induction of labor, PV findings, success rate

Introduction

The process of labor induction is a common obstetric intervention aimed at facilitating childbirth in cases where spontaneous labor is not forthcoming or poses a risk to maternal or fetal health.[1] There has been a notable increase in labor induction rates in recent years, particularly in developed countries.[2,3] The growing global prevalence of cesarean sections has linked this increase to a higher incidence of maternal and newborn complications in subsequent pregnancies.[4] Cervical status significantly influences the effectiveness of labor induction, requiring a thorough assessment to optimize results.5 Bishop score (BS) was initially developed with a minimum score of 6, indicating a favorable cervix, while higher scores are associated with successful induction outcomes.[6] BS is a standardized tool for evaluating cervical favorability before induction, with scores above 5 generally indicating favorable conditions for successful induction.[7-9] The timing of induction techniques also affects their efficacy, underscoring the need for tailored strategies.[10,11] Factors such as previous cesarean deliveries and cervical length further influence induction success.[12,13]

Ultrasonography and elastography could be a more advanced method than just using the traditional Bishop score. Research by Młodawski et al. shows the repeatability and reproducibility of ultrasonographic parameters, indicating that these parameters can effectively function as reliable alternatives to the Bishop score used for labor induction.[14] Alaa and Hak's study further supports this, revealing a stronger correlation between successful labor induction outcomes and transvaginal ultrasound measurements of cervical length than the BS.[15] This suggests that cervical length could serve as a more precise predictor of effective induction, reinforcing the notion that integrating objective ultrasound assessments may enhance the precision of cervical evaluations in clinical practice, as highlighted in Demir's study, which compares the effectiveness of both methods in determining the need for cervical ripening before labor induction.[16] Several studies challenge the assertion that transvaginal ultrasound (TVS) cervical length measurements are a superior alternative to the BS. Bayoumy et al. found that while posterior cervical angle (PCA) and cervical length offer some predictive value, they do not significantly outperform the Bishop score in predicting successful induction of labor (IOL).[17] This suggests that reliance solely on TVS may overlook the nuanced insights provided by the Bishop score, which remains relevant despite its subjectivity. Liu et al. also noted that a multifactorial approach that includes maternal and obstetric factors improves prediction accuracy, showing that cervical length alone is not enough. 18 Research by Alaa and Hak further supports combining

Bishop's score and cervical length to predict successful induction.[15] Furthermore, Al-Adwy et al. found that optimal IOL prediction accuracy was greater than 99.5%.[19] On the other hand, Hemmatzadeh et al. emphasized the significance of the BS, particularly when combined with other clinical parameters, indicating that it remains a valuable tool for evaluating labor induction.[20] Although TVS provides objectivity, BS still holds clinical relevance when integrated into a comprehensive predictive model.

An unfavorable cervix at admission significantly increases the risk of cesarean delivery, regardless of whether labor is induced or not. This underscores the importance of BS in determining the appropriate phase of labor for cesarean delivery, particularly in nulliparous women who are at increased risk for cesarean sections when faced with prolonged pregnancies and unfavorable cervical conditions.[21] Rishitha et al. offer important information on the correlation between cervical status and the rate of cesarean deliveries, especially about labor induction.[22] The study indicates that women with an unfavorable cervix (BS<5) exhibit a significantly higher rate of cesarean delivery rate compared to those with a favorable cervix. Cesarean delivery is indicated for women who have reached full cervical dilation but experience an arresting second stage of labor lasting more than two hours, suggesting that prolonged labor without progress is a critical factor for intervention.[23]

Aim

This implies that inadequate preparation of the cervix for labor induction leads healthcare providers to perform cesarean deliveries more frequently. This evidence shows the significance of cervical assessment in deciding the mode of delivery.

Material and methods

We conducted a prospective observational cohort study at Rising Medicare Hospital, a tertiary hospital in Kharadi, Pune, Maharashtra, India, from 11 March 2021 to 12 September 2023. The study was approved by the ethical committee of the local hospital with approval number ECR/1578/Inst/MH/2021. We strictly followed ethical guidelines. All group members completed the informed consent form and kept all data collected anonymous. 680 women in all who were admitted to the labor room between 11 March 2021 and September 12, 2023, were enrolled in the study. Among them, 187 women were refused participation, while 197 who did not meet the study inclusion criteria were left out. Although, 296 qualified women with comparable clinical and demographic characteristics were finally taken into account for the study and divided into 3 groups: The first group, called "pharmacological methods," included women with a better Bishop score who were induced with 25 µg misoprostol tablets, and women with Bishop scores less than 5 were given 50 µg misoprostol tablets for induction. We administered both tablets vaginally, positioning them in the posterior vaginal fornix for optimal absorption. whereas women who were induced by inserting

dinoprostone 0.5 mg (cerviprime gel), which comes in a disposable syringe containing 3 g of clear gel, were introduced into the cervical canal just below the internal os.

The second group, named 'non-pharmacological (mechanical) methods," included women induced using the Foley transcervical catheter, filled with 30 cubic centimeters (cc), is equivalent to 30 milliliters (mL) of normal saline, inserted into the cervical canal, placed just above the internal os, and inflated to facilitate cervical dilation. Another nonpharmacological intervention is done by stripping the membrane through the insertion of a sterile gloved finger into the cervical canal and advancing it until it reaches the internal cervical os, performing a circular motion with the fingertip to separate the amniotic membranes from the lower uterine segment.

The third group, named 'the combined methods group", employed a mixture of pharmacological and non-pharmacological methods for the IOL. This cohort comprised women who underwent induction using a transcervical Foley's catheter (14 F) filled with 30 cc normal saline, and administered oxytocin at an initial dose of 2 mU every 15 minutes, gradually increasing to a maximum of 40 mU via the intravenous route. Additionally, included women induced by membrane stripping in conjunction with oxytocin administration under the same dosing regimen. The patients were advised to remain in the supine position for 30 minutes after administering all the interventions by the physician. A physician repeated the dose every six hours, up to three maximum doses in a 24-hour period, until they achieved the desired Bishop score and uterine contraction. Healthcare providers perform cesarean delivery if the cervix has not achieved at least 5 cm of dilation and 90% effacement after 36 hours of cervical ripening or 12 hours of activation.[24,25] Healthcare providers will perform fetal monitoring throughout the induction procedure. Labor will start and kept going for at least 12 hours unless certain medical conditions occur, such as signs of fetal distress (persistent slowing or bradycardia), chorioamnionitis (intrapartum temperature 38°C with tenderness in the uterus, foul smelling discharge, or tachycardia in both the mother and baby), arrest in cervical dilation (no change for more than 2 hours during the active phase), arrest in descent (no change in fetal station for more than 1 hour at 8 cm dilation), or failure in descent during the second stage of labor.

Data were collected by structured observations by the investigator. Demographic data was collected from electronic database viz.; care-expert and E-hat hospital software, partograph, and ANC reports of the women. The collected data were recorded in the Excel sheet. Data analyzes were done by using IBM SPSS Statistics version 20 (Armonk, NY, USA), using logistic regression with significance set at $p<0.05$. We expressed the results as an odds ratio and / or a 95% confidence interval.

Statistical tests were performed to present the following

The Pearson correlation coefficient was used to determine the relationship between categorical variables and labor outcomes among participants in the pharmacological, nonpharmacological and combined intervention groups. In the data analysis, categorical variables are compared with Pearson's Chi-square test,

and the importance of independent variables is assessed with likelihood ratio tests. Logistic regression models utilize McFadden's pseudo-R2, Cox and Snell R2, and Nagelkerke R2 to determine explained variation, while multivariate logistic regression examines relative risks for ineffective labor induction techniques, and binomial logistic regression assesses event probabilities like BS results. Statistical significance is determined at $p<0.05$, with correlation measured by Kendall's Taub and changes in proportions evaluated using the McNemar-Bowker test.

Kendall Tau (also known as Kendall's tau rank correlation coefficient) is used for assessing the association between a nominal variable and an ordinal variable.

In the current retrospective observational study, there is no blinding or randomization, as the physician performs the induction according to the indication. Thus, the chances of bias become zero.

The primary outcome measure for this study was the effect of cervical favorability on the success rate of delivery.

Secondary outcome measures were the rate of cesarean deliveries and the onset of active labor (cervical dilation of 4 cm or greater).

Sampling criteria

Inclusion criteria

All pregnant women admitted to the labor room and who were expected to undergo induction.

Exclusion criteria

Less than 18 years of age and less than 37 weeks of gestation, scarred uterus (previous surgery on the uterus, i.e., cesarean delivery), twins, triplet pregnancy or multiple birth pregnancy, breech presentation, fetal anomalies.

Results

This study conducted a comprehensive evaluation to compare the IOL methods in terms of Bishop score and success rate of administering induction doses. Of the 296 women, 58.45% received pharmacological treatments such as misoprostol 25 g, misoprostol 50 g, and dinoprostone gel 0.5 g gel (Fig. 1). On the other hand, 17.91% of women received nonpharmacological methods like Foley's catheter and membrane stripping, while 23.65% received a combination of these methods, including the pharmacological agent oxytocin and a non-pharmacological strategy that involved either stripping a membrane or a balloon catheter.

During the labor induction process, cervical favorability and the rate of successful induction are determined by evaluating cervical status through a per vaginal (PV) examination and BS.

We define the success of labor induction as the commencement of labor pains that are continuous, periodic (at regular intervals), and moderate to strong in intensity.

The outcome of inducing labor is determined by the type of birth that occurs. There were two indicators: the first was the success rate of IOL, the second was the failure of IOL, and the third was the women's abortion from the IOL process. Ultimately, the second indicator shifted the women to a cesarean section.

PV findings before administration of labor induction

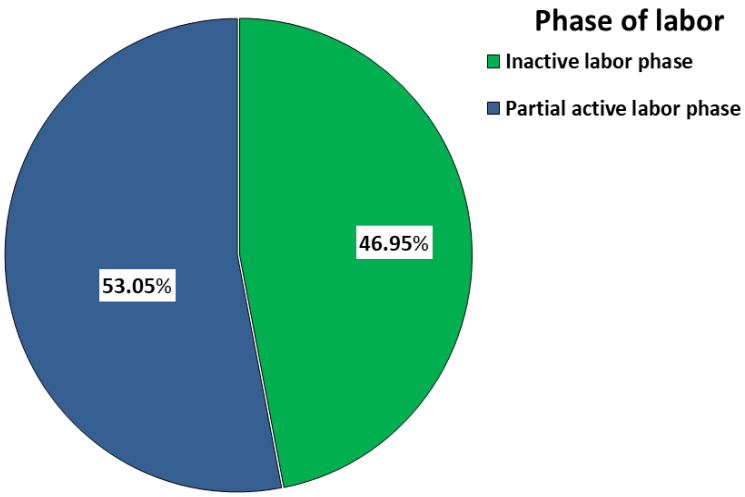

Fig. 1. More than 50% of the patients were in the partial active phase of labor before administering the IOL method to induce it.

PV findings 6 hours after administration of the 1st dose of labor induction

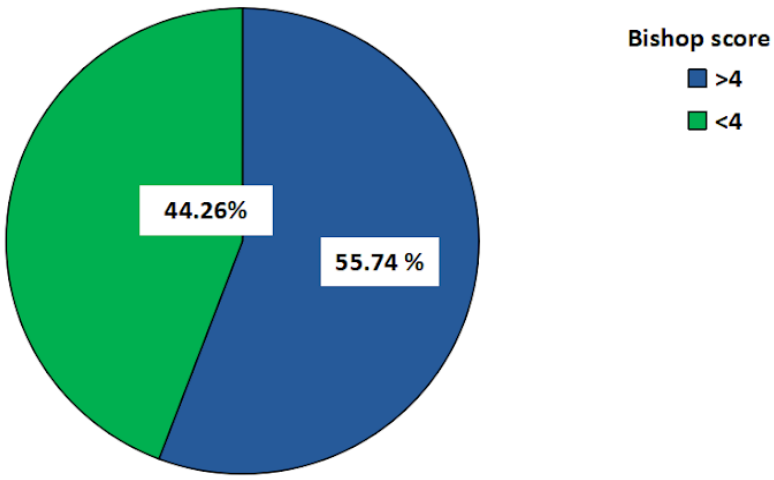

Fig. 2. BS 6 hours after initial dose of IOL

A BS of more than four (>4) showed that 55.74% of the patients had successfully progressed to active labor after the first labor induction intervention. On the other hand, a Bishop score of less than four (<4) indicates that an induction response was not successful in 44.26% of cases, when the patient did not reach active labor (Fig. 2).

The favorability of the findings of the PV examination increased after 6 hours of administration of the first induction dose. This suggests that the first dose contributes to a positive change in the PV examination finding outcomes.

Success ratio of the first dose for induced labor

The success of labor induction is characterized by the onset of labor contractions that are continuous, periodic (occurring at regular intervals) and of moderate to strong intensity. This definition establishes a success ratio for the induction process.[26] People often assess the success of labor induction in conjunction with the delivery mode and they commonly use the rate of cesarean sections as an essential indicator to evaluate the efficacy of the induction strategy.[27]

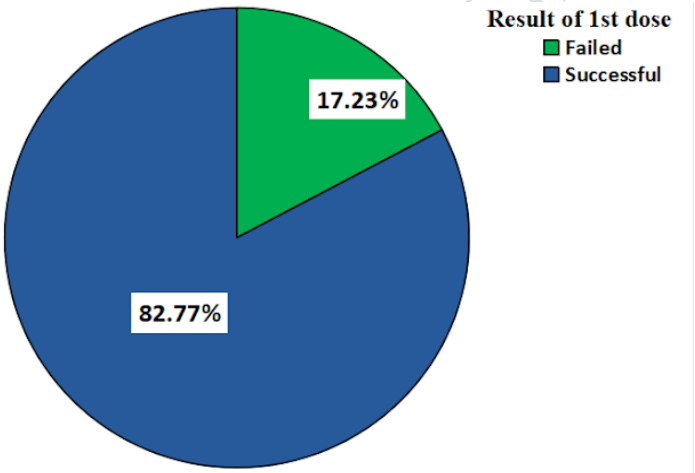

Fig. 3. Result of the first dose of IOL

The first dose was administered to the participants and 82.77% of the patients experienced labor 6 hours after induction, while 17.23% of the patients reported no labor pain starting after the induction (Fig. 3).

Table 1. Maternal parameter

Maternal parameters	**Pharmacological**		**Non-pharmacological**		**Combined**		**p**
Maternal age groups	**Count**	**%**	**Count**	**%**	**Count**	**%**	0.07
18–25	46	15.54	13	4.39	16	5.41	
26–30	75	23.34	21	7.09	32	10.81	

31–35	45	15.2	17	5.74	17	5.74	
36–40	7	2.36	2	0.68	5	1.69	
Maternal height groups							0.035
140–150	24	8.11	6	2.03	7	2.36	
151–160	92	31.08	26	8.78	47	15.88	
161–170	52	17.57	21	7.04	16	5.41	
171–180	5	1.69	0	0	0	0	
Maternal weight groups							0.035
Low weight: <50 kg	0	0	0	0	0	0	
Normal weight: 50–70 kg	82	27.7	23	7.77	33	11.15	
High weight: 71–90 kg	90	30.41	30	10.14	36	12.16	
Very high weight: >90 kg	1	0.34	0	0	0	0	
BMI groups							0.03
Underweight: BMI<18.5	0	0	0	0	0	0	
Normal weight: BMI 18.5–24.9	28	9.46	10	3.38	8	2.7	
Overweight: BMI 25–29.9	79	26.69	23	7.77	39	13.18	
Obese (Class I): BMI 30–34.9	50	16.89	17	5.74	20	6.77	
Obese (Class II): BMI 35–39.9	16	5.41	3	1.01	3	1.01	
Morbidly Obese (Class III): BMI≥40	0	0	0	0	0	0	
Is patient in active labor?							<0.001
No	94	31.76	29	9.79	16	5.41	
Yes	79	26.69	24	8.11	54	18.24	

Differences in maternal parameters such as height, weight, and BMI, along with the status of active labor, are significant between induction methods, particularly with a higher likelihood of active labor in combined methods (Tables 1 and 2).

Table 2. Variables in the equation

	B	**S.E.**	**Wald**	**df**	**p**	**Exp (B)**	**95% CI for Exp (B)**	
							Lower	**Upper**
Age	-0.085	0.031	7.360	1	0.007	0.918	0.863	0.977
Height	-0.333	0.158	4.431	1	0.035	0.717	0.526	0.977
Weight	0.365	0.173	4.434	1	0.035	1.441	1.026	2.024
BMI	-0.927	0.427	4.715	1	0.030	0.396	0.171	0.914

Active labor	-1.226	0.264	21.585	1	0.000	0.293	0.175	0.492
Constant	56.479	24.922	5.136	1	0.023	3375304545784402000000000.000		

From the above table, we get the fitted logistic regression model as follows:

Log odds=56.479+(-1.226*active)+(-0.927* BMI)+(0.365* weight)+(-0.333* height)+(-0.085*age)

Methods of IOL-wise BS of first dose

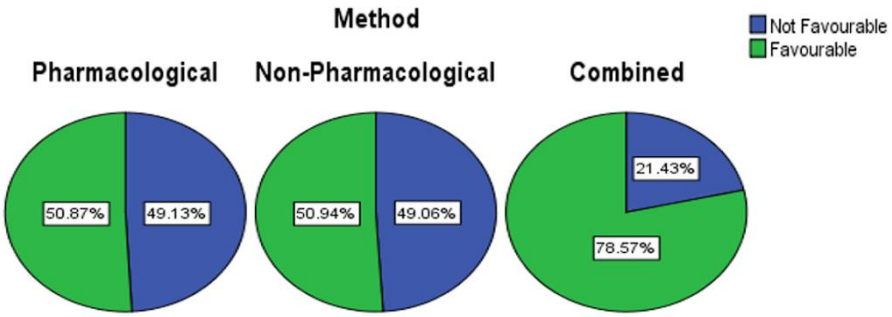

Fig. 4. IOL wise Bishop score 6 hours after the first dose

Six hours after administering the first dose, the combined IOL methods demonstrated the highest favorable Bishop score of 78.57%, which ranged from "7 cm cervix dilated, station -2, 70-80% effacement" to "fully dilated, fully effaced station 0," while the pharmacological and nonpharmacological IOL methods yielded similar results (50.87%) and (50.94%), respectively, with a p<0.001 (Fig. 4).

Methods of IOL-wise success rate of first dose

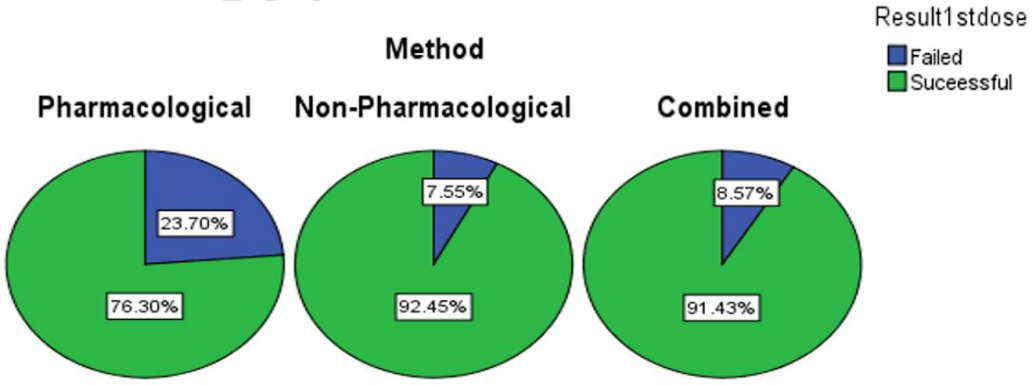

Fig. 5. Methods of IOL-wise success rate 6 hours after first dose

Six hours after administering the first dose, the non-pharmacological methods of IOL showed a higher success rate of 92.45%, while combined methods yielded equivalent results of 91.43% compared to pharmacological methods of IOL of 78.30%, with a p-value of 0.002 (Fig. 5).

Comparison of the induction-wise mode of delivery

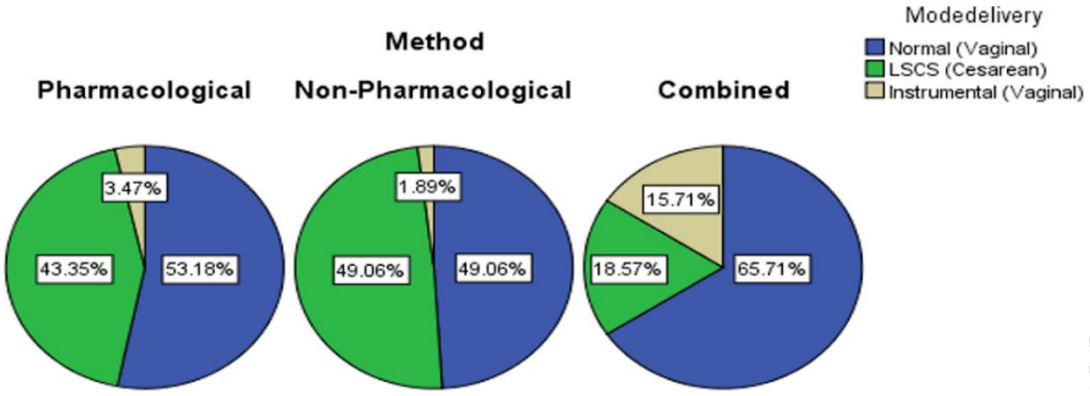

Fig. 6. Comparison of the induction-wise mode of delivery

Combined methods of IOL showed the highest normal delivery rates, 65.71%, compared to pharmacological, 53.18% and non-pharmacological, 49.06%, with negligible instrumental (vaginal) delivery rates (Fig. 6).

Only 18.57% of the patients underwent a cesarean section using combined IOL methods, while both pharmacological and non-pharmacological IOL methods had higher cesarean rates of 43.35% and 49.06%, respectively.

Table 3. Case processing summary*

Methods	**Count**	**Marginal percentage**
Pharmacological	173	58.4%
Non-pharmacological	53	17.9%
Combined	70	23.6%
Valid	296	100%
Missing	0	
Total	296	
Sub-population	296[a]	

* [a] The dependent variable has only one value observed in 296 (100%) subpopulations

Pharmacological methods are the most frequently used, followed by combined and non-pharmacological methods. All observations are valid, with no missing data (Table 3).

Table 4. Model fitting information

Model	Model fitting criteria			Likelihood ratio tests		
	AIC	BIC	-2 Log likelihood	Chi-square	df	p
Intercept only	574.014	581.394	570.014			
Final	551.823	706.818	467.823	102.191	40	<0.001

We evaluated the model's fitness using the chi-square statistic. The chi-square value was 102.191, and the $p<0.001$ is less than the significance level of 0.05. This shows that there is a relationship between the different methods of induction and other independent variables such as vaginal findings and BS in the final fitted model (Table 4).

Table 5. Goodness of fit

	Chi-Square	df	p
Pearson	567.121	550	0.298
Deviance	467.823	550	0.995

Here, $p = 0.298$ is greater than the 0.05 level of significance (Table 5). Therefore, we are unable to reject the null hypothesis at the 5% level of significance. That is, we concluded that the given model fits the data very well.

Table 6. Pseudo R-Square

Cox and Snell	0.292
Nagelkerke	0.342
McFadden	0.179

The Cox and Snell $R^2=0.290$ value suggests that the model explains approximately 29.2% of the variance in the dependent variable, but it cannot reach a maximum of 1, which limits its interpretation (Table 6).
Nagelkerke $R^2=0.342$ is an adjusted version of Cox and Snell's R^2, rescaled to cover the full range (0 to 1). It indicates that the model explains 34.2% of the variance.
The McFadden value suggests that the model explains 17.9% of the variance and is typically lower than other pseudo-R^2 values, but still a reasonable fit.
These values provide different perspectives on the model's fit, with Nagelkerke showing the highest adjusted explanation of variance.

Discussion

The present study investigates the intricate mechanisms underlying labor induction techniques, particularly the relationship between BS and delivery outcomes.

Although nonpharmacological IOL methods achieved more favorable cervical conditions, we observed a higher incidence of cesarean sections, suggesting that these interventions do not consistently lead to better outcomes of delivery. In contrast, combined IOL methods demonstrated the highest rates of normal delivery and were equally effective in enhancing cervical status or Bishop scores while significantly reducing cesarean section rates. The study found that 46.95% of the patients had poor cervical conditions before IOL strategies were used. These included a closed os, a posterior cervix, and a high fetal head. This meant they had a low Bishop score and a lower chance of going into labor on their own (Fig. 1).

However, 53.04% of patient were in a somewhat or partially active labor phase, with a cervix that was 1 cm dilated, 40% effaced and the fetal station at -2, which means that the conditions for labor were good (Fig. 1). These findings corroborate the existing literature that highlights the challenges associated with low BS. Studies frequently link a BS below 6 to reduced chances of spontaneous labor and an increased likelihood of cesarean delivery during IOL.[28-30] This is particularly pertinent as studies indicate that patients with unfavorable cervical conditions are less likely to experience spontaneous labor, necessitating surgical interventions for delivery.[29] Research has shown that a moderate BS increases the likelihood of successful induction with fewer cesarean deliveries.[19] Advanced methods such as ultrasound and elastography may provide more accurate assessments than the traditional Bishop score.[14]

In this study, 55.74% of the patients exhibited a favorable BS of more than four (>4) following the initial dose of labor induction, suggesting successful progression to active labor (Fig. 2). This finding aligns with Grobman et al.'s research, which indicates that a favorable BS, defined as greater than four, correlates with a higher likelihood of successful labor induction and a lower cesarean delivery rate. Specifically, their findings demonstrated that the patient with a favorable Bishop score experienced more favorable outcomes compared to those with an unfavorable score, consistent with the observation that 55.74% of the patients in this study achieved a favorable score after induction.31 This correlation underscores the importance of the Bishop score in predicting successful labor outcomes. Researchers who looked at different methods to induce labor, such as the Foley catheter and pharmacological agent such as oxytocin, found that nonpharmacological methods can work well even with lower BS (4-5), while pharmacological methods usually need a higher threshold (6 8) for the best success rates.[31] Studies show that a BS of 5 is a strong indicator of the need for a cesarean section due to failed attempts to induce labor. This shows how important the initial cervical status is.[31-33]

In this study, 44.26% of the patients did not meet the favorable threshold, with a BS of less than four indicating a lower probability of progressing to active labor (Fig. 2). This finding is consistent with the systematic review by Kolkman et al., which emphasized the BS's predictive capacity of BS for labor

induction success.[28] A study by Iftikhar shows that using both BS and transvaginal sonography together can help predict whether or not an induction will work. This suggests that BS is useful, but it may not be the only thing that determines whether or not an induction will work34.

Among the 296 patients, 82.77% successfully induced labor, while only 17.23% did not progress six hours after the initial dose (Fig. 3). The high success rate fits Msumi's research, which shows that cervix conditions of the cervix during induction have a big effect on how many babies are born alive35. The importance of cervical ripening for good results is emphasized. This correlation indicates that a properly prepared cervix is a significant predictor of successful labor induction, consistent with the results presented. Research by Bekru and Yirdaw demonstrated that a BS of five or less is a major risk factor for failed induction, revealing that a significant percentage of patients with low BS experienced unsuccessful labor induction.[36] This aligns with the observed failure rate of 17.23%, suggesting that certain clinical scenarios could potentially predispose patient to an unsuccessful induction. This highlights the importance of cervical status in forecasting induction success, potentially elucidating the failure rates observed in the present study.

A study by Haavaldsen et al. looked at the increasing use of labor induction and how it affects the outcome of pregnancies. They found that although overall induction rates have increased, the risks of bad outcomes, such as failed induction, are still a big concern. This underscores the importance of careful patient selection and monitoring during the induction process to mitigate the risk of failure.[37]

Kim et al. identified that factors such as maternal age, parity, and initial BS significantly influence labor induction success.[38] Research indicates that specific maternal characteristics can predict the likelihood of successful vaginal delivery after induction, emphasizing the importance of individualized assessment prior to the induction process.

Table 1 compares maternal parameters across pharmacological, non-pharmacological and combined labor induction methods, highlighting significant differences in height, weight, BMI, and active labor status. Most pharmacological patients fell within the 26–30 age group and the 151–160 cm height range, with a significant portion categorized as high weight (71–90 kg) and overweight (BMI 25–29.9). Combined methods resulted in a higher proportion of patients in active labor, while fewer patients fell into the very high-weight or morbidly obese BMI categories across all groups. Statistically significant differences ($p<0.05$) indicate that combined induction is associated with active labor status, while specific height and weight groups are more prevalent in pharmacological cases. The data supports the hypothesis that maternal factors such as height, weight, and BMI significantly affect active labor across induction methods. Table 1 links certain maternal characteristics with labor induction outcomes.

Hirshberg et al. found a negative correlation between maternal weight and cervical dilation rate after induction, suggesting that a heavier patient may experience longer labors. This supports the idea that maternal factors influence active labor potential in induction strategies.[37] Rogaleli and Awang found that

shorter maternal height increases cesarean sections and prolongs obstructed labor, implying that maternal height may affect labor mechanics and induction success.[39]

Ghazali's study highlights the impact of maternal BMI on the length of induced labor, noting that higher BMI is associated with slower labor progression and higher cesarean birth rates.[40] This association is significant as it suggests that patients with higher BMIs may face more challenges in inducing labor, affecting their chances of achieving active labor. The results support maternal weight and BMI as critical considerations in the development of induction techniques (Table 1). The meta-analysis by Sotiriadis et al. supports the assertion that maternal factors significantly affect induction outcomes, finding that maternal BMI and height influence labor outcomes after elective induction.[41]

The logistic regression model showed that active labor cut the chances of unsuccessful induction by 70.7% (Exp(B)=0.293), which is a solid result ($p<0.001$) with a confidence interval of 0.175 to 0.492. The significant value of the constant term Exp (B) value indicates a baseline effect on the outcome when all predictors are zero, with the intercept of the model being significant ($p=0.023$). A strong correlation was discovered between active labor and successful outcomes, with the probability of a favorable outcome for the patient not in active labor being approximately 29.3% lower than for those who had a statistically significant difference ($p<0.001$) (Table 2). This effect has a narrow confidence interval (17.5% to 49.2%), indicating the reliability of the estimate.

A good Bishop score of 78.57% within six hours of administration was observed in several studies (Fig. 3), which supports the results (Fig. 4) of combined IOL methods. These studies highlight the advantages of utilizing a combination of nonpharmacological and pharmacological approaches. A systematic review by Chen et al. compared the use of Foley catheters, misoprostol, and dinoprostone for cervical ripening. They found that mechanical methods, such as the Foley catheter, combined with pharmacological agents, such as oxytocin, made the cervical area more ready for delivery, leading to more vaginal deliveries and fewer cesarean deliveries.28 Numerous studies have shown that the use of a Foley catheter followed by oxytocin improves Bishop scores, increases vaginal birth rates, and decreases cesarean section rates.[26,27,42,43,44] This study revealed that nonpharmacological approaches to IOL demonstrated a more favorable Bishop score of 92.45% compared to the pharmacological method 76.3%. Additionally, combined methods showed a favorable Bishop score of 91.43% after initial administration (Fig. 5). This suggests that, while combining both methods can lead to more favorable outcomes, careful consideration of the associated risks is necessary. Juncu's systematic review emphasized the importance of evaluating various IOL methods, including pharmacological and nonpharmacological methods, to determine their effectiveness in different clinical scenarios.[45] While combined methods can produce better outcomes, the review found that optimizing induction success rates also requires consideration of individual patient factors and clinical contexts.

Conclusion

The findings show that a more effective method may involve a combination of nonpharmacological and pharmacological methods, potentially enhancing Bishop's score and delivery outcomes, increasing the likelihood of successful vaginal delivery.

Declarations

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Author contributions

Conceptualization, P.S.U. and V.N.M.; Methodology, L.R.V.; Statistical Software P.S.U.; Validation, P.S.U., V.N.M. and L.R.V.; Formal Analysis, P.S.U.; Investigation, P.S.U.; Resources, P.S.U.; Data Curation, P.S.U.; Writing – Original Draft Preparation, P.S.U.; Writing – Review & Editing, P.S.U.; Visualization, P.S.U.; Supervision, P.S.U. and V.N.M.; Project Administration, P.S.U.; Funding Acquisition, P.S.U.

Conflicts of interest

No conflicts of interest.

Data availability

Data related with induction of labor were collected by the structured observations and demographic data were collected from electronic database viz.; care-expert and E-hat hospital software, partograph and ANC reports of the patients. The collected data were recorded in the excel sheet.

Ethics approval

The study protocol was approved by the local ethics committee of the Rising Medicare Hospital. The permission was granted from the director and professor in charge of the hospital. Registration No: ECR/1578/Inst/MH/2021, registration date is 30 September 2021.

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