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Determinants of cesarean section following induction of labor in term nulliparous pregnancies

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Abstract
Background: Induction of labor (IOL) is a common obstetric intervention, yet it is frequently associated with higher cesarean section (CS) rates, particularly in nulliparous women. Identifying determinants of CS following IOL can guide clinical decision-making and improve outcomes.
Objective: To evaluate maternal, fetal, and obstetric factors influencing CS rates among term nulliparous women undergoing IOL.
Methods: This hospital-based observational case-control study was conducted at Dr. Rajendra Prasad Government Medical College, Kangra at Tanda, Himachal Pradesh. Two hundred nulliparous women with singleton term pregnancies undergoing IOL were enrolled 100 who underwent CS after IOL (Group A) and 100 who delivered vaginally (Group B). Data on demographic parameters, comorbidities, Bishop score, indications for induction, and delivery outcomes were collected. Statistical analysis included chi-square and t-tests, with odds ratios (OR) and 95% confidence intervals (CI) calculated for risk factors.
Results: Mean maternal age and BMI were significantly higher in Group A (27.09 ± 4.34 years, 24.71 ± 3.37 kg/m²) than Group B (25.00 ± 3.88 years, 22.91 ± 2.17 kg/m²) ($p = 0.001$ and $p = 0.002$, respectively). Bishop score was significantly lower in Group A (3.78 ± 0.76) versus Group B (4.41 ± 0.95; $p = 0.001$). Hypertensive disorders (OR 2.60, $p = 0.008$) and diabetes mellitus (OR 2.25, $p = 0.046$) were significant predictors of CS. Postdated pregnancy was associated with a reduced CS risk (OR 0.37, $p = 0.001$). Acute fetal distress (72%) failed induction (19%), and non-progression of labor (9%) were the main CS indications. Neonatal outcomes were comparable, although respiratory distress was more frequent in Group A.
Conclusion: Higher maternal BMI, lower Bishop score, hypertensive disorders, and diabetes mellitus significantly increase the likelihood of CS following IOL in term nulliparous pregnancies, whereas postdated pregnancy reduces this risk. Careful pre-induction assessment and individualized management may optimize outcomes and reduce unnecessary cesarean deliveries.

Keywords: Induction of labor, cesarean section, nulliparous women, bishop score

Introduction

The ability to regulate the onset of labor, either by initiating or delaying it, represents a significant advancement in modern obstetrics. Induction of labor (IOL) refers to the artificial initiation of uterine contractions before the spontaneous onset of labor, undertaken when the anticipated benefits to the mother or fetus outweigh the potential risks of continuing the pregnancy [1]. Globally, approximately 20–30% of all pregnancies undergo IOL, and this rate continues to rise [2]. The primary objective of IOL is to achieve vaginal delivery as naturally as possible while ensuring optimal maternal and perinatal outcomes.

Common indications for IOL include post-term pregnancy, premature rupture of membranes (PROM), oligohydramnios, intrauterine growth restriction (IUGR), and maternal medical disorders such as gestational hypertension and diabetes mellitus [3]. However, cesarean section (CS) rates following IOL have raised concerns, with evidence suggesting that both the indications for induction and the maternal-fetal characteristics significantly influence the likelihood of CS [4]. In India, the National Family Health Survey-4 reports a CS rate of 17.2%, exceeding the World Health Organization (WHO) recommendation that rates above 10% indicate potential overuse [5]. Certain maternal factors—such as advanced maternal age, high body mass index (BMI), low pre-induction Bishop score, hypertensive disorders, diabetes, post-term gestation, fetal growth restriction, PROM, oligohydramnios, and high estimated fetal weight—are consistently associated with increased CS risk after induction [3,6, 9].

Advanced maternal age (≥35 years) has been linked with increased antenatal complications, including chronic hypertension, preeclampsia, gestational diabetes, and placenta previa, which may necessitate induction and increase CS rates [6, 10]. Similarly, nulliparity is an independent risk factor, with IOL in nulliparous women—particularly with an unfavorable cervix—leading to a higher incidence of failed induction and CS [4, 8]. Obesity (BMI ≥25 kg/m² for Asian populations) is also associated with longer labor, reduced uterine contractility, and increased operative delivery rates [9, 11].

The Bishop score remains a key predictor of IOL success, with a score <5 indicating an unripe cervix and significantly increasing the likelihood of CS [1, 8]. Medical conditions such as gestational diabetes mellitus (GDM) and hypertensive disorders further compound this risk by increasing the incidence of macrosomia, fetal distress, and labor abnormalities [3, 7]. Additionally, post-term pregnancy is associated with increased fetal weight, oligohydramnios, and decreased placental function, further contributing to emergency CS rates [12].

Given the multifactorial nature of CS risk following IOL in term nulliparous pregnancies, it is essential to identify and quantify these determinants. This case-control study was conducted to evaluate the maternal, fetal, and obstetric factors influencing CS rates in induced term nulliparous women, thereby aiding in informed decision-making and optimizing outcomes.

Material and Methods

This observational case-control study was conducted in the labour ward of the Department of Obstetrics and Gynaecology at Dr. Rajendra Prasad Government Medical College, Kangra at Tanda, Himachal Pradesh, after obtaining approval from the Institutional Ethics Committee. The aim was to identify maternal, fetal, and obstetric factors influencing the risk of cesarean section (CS) in nulliparous women undergoing induction of labor (IOL) at term. All participants provided informed written consent before enrollment. Cases comprised nulliparous women who underwent emergency CS after IOL (Group A), while controls were nulliparous women who achieved vaginal delivery after IOL (Group B). Women aged 18–40 years, with a live singleton pregnancy in vertex presentation at ≥37–42 weeks' gestation, and induced using the standard institutional protocol (vaginal misoprostol 25 µg every 4 hours, maximum five doses in 24 hours) were included. Exclusion criteria were scarred uterus (previous CS, myomectomy, or metroplasty), malpresentation, multiple gestations, uterine malformation, contracted pelvis, and multiparity.

On admission, detailed demographic, medical, and obstetric histories were recorded. Clinical assessment included general and systemic examination, obstetric abdominal examination to assess fetal lie, presentation, and heart rate, and per speculum examination for liquor characteristics. Pelvic assessment involved Bishop score calculation and evaluation of pelvic adequacy. Baseline investigations included hemoglobin, fasting and postprandial glucose, and urine routine microscopy. Following induction, all women were monitored for maternal and fetal well-being using cardiotocography (CTG) and partographic documentation. Standard WHO Labour Care Guide protocols were followed during active labor. Post-delivery, women were observed for at least two hours for vital parameters, uterine tone, and postpartum bleeding.

Data collected included maternal age, body mass index (BMI), pre-induction Bishop score, presence of hypertensive disorders of pregnancy, gestational diabetes mellitus, post-term pregnancy, intrauterine growth restriction (IUGR), premature rupture of membranes (PROM), oligohydramnios, birth weight, and indications for induction and for CS. Composite maternal morbidity—defined as any occurrence of severe perineal laceration, blood transfusion, endometritis, wound sepsis, venous thromboembolism, hysterectomy, ICU admission, or maternal death—was also noted. All participants were followed up to six weeks postpartum to document late maternal complications such as puerperal infection, secondary postpartum hemorrhage (PPH), urinary tract infection (UTI), wound separation, and thromboembolic events.

Data were entered in Microsoft Excel and analyzed using Epi Info and SPSS version 21.0 (IBM, USA). Quantitative variables were expressed as mean ± standard deviation and compared using the independent t-test, while categorical variables were expressed as proportions and compared using the chi-square test. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to determine the strength of association between potential risk factors and CS following IOL. A p-value of <0.05 was considered statistically significant.

Results

Maternal Demographic Characteristics of Study Participants

Table 1 presents the baseline demographic characteristics of the two study groups—Group A (cases) and Group B (controls), each with 100 participants. The mean maternal age was significantly higher in Group A (27.09 ± 4.34 years) compared to Group B (25.00 ± 3.88 years) with a p-value of 0.001, indicating statistical significance. Similarly, the mean body mass index (BMI) was significantly higher in Group A (24.71 ± 3.37 kg/m²) than in Group B (22.91 ± 2.17 kg/m²) with a p-value of 0.002. The period of gestation was slightly lower in Group A (272.12 ± 6.98 days) compared to Group B (274.41 ± 7.85 days), but this difference was not statistically significant (p = 0.10). The Bishop score, which assesses cervical readiness for labor, was significantly lower in Group A (3.78 ± 0.76) than Group B (4.41 ± 0.95), with a p-value of 0.001, suggesting less favorable cervices in the cases group.

Table 1: Maternal Demographic Characteristics of Study Participants (N = 200)

Variable	Group A (Cases, n=100)	Group B (Controls, n=100)	p-value
Age (years), mean ± SD	27.09 ± 4.34	25.00 ± 3.88	0.001*
BMI (kg/m²), mean ± SD	24.71 ± 3.37	22.91 ± 2.17	0.002*
Period of gestation (days), mean ± SD	272.12 ± 6.98	274.41 ± 7.85	0.10
Bishop score, mean ± SD	3.78 ± 0.76	4.41 ± 0.95	0.001*

Indications for Induction of Labor

Table 2 summarizes the clinical indications for labor induction among both groups. Postdated pregnancy was a significantly more common indication in Group B (41%) compared to Group A (21%), with a p-value of 0.003. Hypertensive disorders of pregnancy were more frequent in Group A (28%) than in controls (13%), with a significant p-value of 0.004. Diabetes mellitus was also more common in Group A (20%) than in Group B (10%), reaching statistical significance (p = 0.003). Other indications including intrahepatic cholestasis, premature rupture of membranes (PROM), intrauterine growth restriction (IUGR), decreased fetal movement, and oligohydramnios showed no significant difference between groups.

Table 2: Indications for Induction of Labor

Indication	Group A n (%)	Group B n (%)	*p*-value
Postdated pregnancy	21 (21.0)	41 (41.0)	0.003*
Hypertensive disorders of pregnancy	28 (28.0)	13 (13.0)	0.004*
Diabetes mellitus	20 (20.0)	10 (10.0)	0.003*
Intrahepatic cholestasis	11 (11.0)	12 (12.0)	0.824
PROM	9 (9.0)	7 (7.0)	0.795
IUGR	7 (7.0)	8 (8.0)	0.788
Decreased fetal movement	4 (4.0)	7 (7.0)	0.537
Oligohydramnios	1 (1.0)	2 (2.0)	0.561

Indications for Cesarean Section in Group A

Table 3 lists the primary reasons for cesarean delivery among the 100 women in Group A. Acute fetal distress was the leading indication, accounting for 72% of cesarean sections. Failed induction was the second most common cause, comprising 19% of cases. Non-progression of labor accounted for 9% of cesarean deliveries. This distribution highlights fetal distress as the predominant cause for cesarean in women undergoing induction.

Table 3: Indications for Cesarean Section in Group A (n = 100)

Indication	N	%
Acute fetal distress	72	72.0
Failed induction	19	19.0
Non-progression of labor	9	9.0

Neonatal Outcomes

Table 4 compares key neonatal outcomes between the two groups. The mean birth weight was slightly higher in Group A (2884.51 ± 366.26 g) compared to Group B (2797.03 ± 369.55 g), but this difference was not statistically significant (p = 0.094). NICU admission rates were comparable between groups (15% in Group A and 12% in Group B; p = 0.680). Among NICU admissions, neonatal jaundice was the most common indication in both groups (53.3% in Group A and 50% in Group B). Respiratory distress was more frequent in Group A (46.7%) than Group B (16.7%). Low birth weight and hypoglycemia as NICU admission reasons were only observed in Group B neonates. Overall, neonatal outcomes were largely similar between groups.

Table 4: Neonatal Outcomes

Variable	Group A (n=100)	Group B (n=100)	*p*-value
Birth weight (g), mean ± SD	2884.51 ± 366.26	2797.03 ± 369.55	0.094
NICU admission, n (%)	15 (15.0)	12 (12.0)	0.680
Indications for NICU admission			
- Neonatal jaundice	8 (53.3)	6 (50.0)	0.180
- Respiratory distress	7 (46.7)	2 (16.7)	
- Low birth weight	0 (0.0)	3 (25.0)	
- Hypoglycemia	0 (0.0)	1 (8.3)	

Association of Antepartum Risk Factors with Cesarean Section Following Induction of Labor

Table 5 illustrates the relationship between various antepartum risk factors and the likelihood of cesarean section after induction of labor. Higher BMI (≥25 kg/m²), low Bishop score (<5), hypertensive disorders, and diabetes mellitus were all significantly associated with increased cesarean rates (p-values 0.001, 0.002, 0.008, and 0.046 respectively). Women aged ≥35 years had a higher cesarean rate, but this was not statistically significant (p = 0.163). Interestingly, postdated pregnancy was associated with a significantly lower cesarean section rate (OR 0.37, p = 0.001). Other factors such as PROM, IUGR, oligohydramnios, and higher birth weight did not show a significant association with cesarean delivery. This table highlights important clinical predictors for cesarean section following labor induction

Table 5: Association of Antepartum Risk Factors with Cesarean Section Following IOL

Risk Factor	CS Rate n (%)	OR (95% CI)	p-value
Age ≥35 years	10/14 (71.4)	2.67 (0.807–8.803)	0.163
BMI ≥25 kg/m²	41/60 (68.3)	2.96 (1.564–5.612)	0.001*
Bishop score <5	81/132 (61.4)	4.09 (2.17–7.73)	0.002*
Hypertensive disorders	28/41 (68.3)	2.60 (1.26–5.39)	0.008*
Diabetes mellitus	20/30 (66.7)	2.25 (1.01–5.00)	0.046*
Postdated pregnancy	21/62 (33.9)	0.37 (0.20–0.67)	0.001*
PROM	9/16 (56.3)	1.16 (0.41–3.28)	0.795
IUGR	7/15 (46.7)	0.88 (0.28–2.72)	0.788
Oligohydramnios	1/3 (33.3)	0.49 (0.04–5.64)	0.561
Birth weight ≥3.5 kg	5/9 (55.6)	2.16 (0.56–8.33)	0.257

Discussion

This study evaluated maternal demographic characteristics, indications for induction of labor (IOL), cesarean section (CS) indications, neonatal outcomes, and antepartum risk factors associated with cesarean delivery following IOL in a cohort of 200 women. The findings offer important insights into factors influencing labor induction outcomes.

The mean maternal age was significantly higher in cases compared to controls, consistent with prior studies that have reported increased obstetric risks and higher rates of cesarean section in older mothers [13, 14]. Similarly, higher BMI was observed in the case group and was significantly associated with increased CS risk, corroborating existing evidence linking maternal obesity with labor complications and operative deliveries [15, 16]. The lower Bishop scores in cases indicate less favorable cervical conditions at induction, which is a well-known predictor of induction failure and cesarean section [17].

The distribution of indications for labor induction differed significantly between groups. Postdated pregnancy was more frequent among controls, while hypertensive disorders and diabetes mellitus predominated in the case group. This aligns with prior literature emphasizing hypertensive disorders as common high-risk indications for IOL, often necessitating timely delivery to reduce maternal and fetal morbidity [18, 19]. Diabetes mellitus was also more prevalent among cases, supporting studies that associate diabetes with increased induction and cesarean rates [20].

The cesarean section rate following IOL was notably high among women with acute fetal distress, failed induction, and non-progression of labor, paralleling observations from other cohorts where fetal compromise and labor dystocia were

primary indications for operative delivery [21, 22]. The neonatal outcomes, including birth weight and NICU admissions, were comparable between groups, although respiratory distress was more frequent in the cases, which may reflect the higher prevalence of maternal comorbidities affecting neonatal adaptation [23].

Importantly, risk factors such as BMI ≥25 kg/m², Bishop score <5, hypertensive disorders, and diabetes were significantly associated with increased cesarean rates, consistent with existing predictive models for CS following induction [24, 25]. Conversely, postdated pregnancy was associated with a decreased risk of cesarean section, which may be due to better cervical favorability and less complicated clinical scenarios in this group [26]. Other factors, including PROM, IUGR, and oligohydramnios, did not show significant associations, possibly due to small sample sizes or heterogeneous clinical presentations.

The study reinforces the need for careful maternal assessment before induction, particularly considering BMI, cervical status, and comorbidities, to optimize delivery outcomes. Strategies such as cervical ripening, close monitoring, and tailored management protocols may help reduce cesarean rates in high-risk inductions.

Conclusion

In this study, maternal factors such as higher age, elevated BMI, and lower Bishop scores were significantly associated with increased rates of cesarean section following induction of labor. Hypertensive disorders and diabetes mellitus also contributed to a higher likelihood of cesarean delivery, whereas postdated pregnancy was associated with a reduced risk. Neonatal outcomes were largely comparable between groups, although respiratory distress was more common in the cases. These findings highlight the importance of careful assessment of maternal risk factors and cervical readiness to optimize induction outcomes and potentially reduce cesarean rates. Tailored management strategies may improve both maternal and neonatal outcomes in women undergoing labor induction

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