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Risk factors for cesarean delivery following induction of labor in nulliparous women at term: A case-control study

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Abstract
Background: Induction of labour (IOL) is a common obstetric intervention intended to achieve vaginal delivery when continuation of pregnancy poses risks to the mother or fetus. However, in nulliparous women, IOL is associated with a higher likelihood of cesarean delivery, particularly in the presence of certain maternal and obstetric risk factors. Understanding these predictors is essential for optimizing outcomes and guiding clinical decisions.
Aim: To identify maternal and obstetric risk factors associated with cesarean delivery following induction of labour in nulliparous women at term.
Methods: This hospital-based case-control study was conducted in the Department of Obstetrics and Gynaecology at Dr. Rajendra Prasad Government Medical College, Kangra at Tanda. A total of 200 nulliparous women at 37–42 weeks gestation who underwent IOL were enrolled, comprising 100 cases (emergency cesarean after IOL) and 100 controls (vaginal delivery after IOL). Data collected included demographic parameters, BMI, pre-induction Bishop score, indications for induction, obstetric risk factors, and maternal and neonatal outcomes. Statistical analysis was performed using chi-square and t-tests, with odds ratios (OR) and 95% confidence intervals (CI) calculated; $p < 0.05$ was considered significant.
Results: Higher BMI (≥25 kg/m²; OR = 2.96, p = 0.001), Bishop score <5 (OR = 4.09, p = 0.002), hypertensive disorders of pregnancy (OR = 2.60, p = 0.008), and diabetes mellitus (OR = 2.25, p = 0.040) were significantly associated with cesarean delivery after IOL. Acute fetal distress was the most common cesarean indication (72%), followed by failed induction (19%) and non-progression of labour (9%). Other factors, including maternal age ≥35 years, PROM, IUGR, oligohydramnios, and birth weight ≥3.5 kg, were not statistically significant predictors. Neonatal outcomes, including birth weight and NICU admission rates, were comparable between groups.
Conclusion: Maternal obesity, low Bishop score, and comorbidities such as hypertensive disorders and diabetes significantly increase the risk of cesarean delivery in nulliparous women undergoing IOL at term. Early identification of these risk factors, along with individualized induction strategies and close intrapartum monitoring, may improve vaginal delivery rates and reduce unnecessary cesarean sections.

Keywords: Induction of labour, cesarean delivery, nulliparous women, risk factors, bishop score, maternal obesity, hypertensive disorders, diabetes mellitus

Introduction

The ability to control the onset of labor, either by initiating or delaying it, is among the most significant advances in modern obstetrics. Induction of labor (IOL) refers to the artificial initiation of uterine contractions before the spontaneous onset of labor, performed when the anticipated benefits to the mother or fetus outweigh the risks of continuing the pregnancy [1]. Globally, approximately 20–30% of all pregnancies undergo induction, and the rate continues to rise [2]. The goal of IOL is to achieve a successful vaginal delivery in situations where maternal or fetal indications necessitate delivery to improve perinatal outcomes.

Common indications for IOL include post-term pregnancy, premature rupture of membranes (PROM), oligohydramnios, intrauterine growth restriction (IUGR), and maternal medical conditions such as gestational hypertension and diabetes mellitus [2]. However, the procedure is not without risks. It is essential to determine whether the induction itself or the underlying clinical condition prompting induction contributes more significantly to the cesarean section (CS) rate [3].

According to the World Health Organization (WHO), CS rates above 10% may reflect overuse without corresponding improvement in maternal or neonatal outcomes [4]. The National Family Health Survey-4 (NFHS-4) reports that 17.2% of births in India are delivered by CS, exceeding WHO recommendations [5]. Several studies have identified specific maternal and obstetric factors that increase the likelihood of CS following IOL, including advanced maternal age, nulliparity, high body mass index (BMI), low pre-induction Bishop score, diabetes, hypertensive disorders of pregnancy, post-term gestation, IUGR, PROM, oligohydramnios, and high estimated fetal weight [2, 6, 7].

Advanced maternal age, defined as ≥35 years, has been linked to increased antenatal complications such as chronic hypertension, preeclampsia, gestational diabetes, and placenta previa, which in turn are associated with a higher likelihood of IOL and subsequent CS [6, 8]. Nulliparity itself is an established independent risk factor for CS, particularly when the indication for induction is fetal compromise, such as IUGR or oligohydramnios [2, 7].

Obesity is another major concern, as women with BMI ≥25 kg/m² (per Asian Indian guidelines) are more prone to failed induction, prolonged labor, and operative deliveries. This is partly due to altered oxytocin receptor sensitivity and reduced myometrial contractility [9, 10]. Similarly, a low Bishop score (<5) before induction is strongly associated with an increased likelihood of CS [1, 7].

Medical disorders such as gestational diabetes and hypertensive disorders of pregnancy further compound the risk, often necessitating earlier delivery and increasing the chance of failed induction [11, 13]. Post-term pregnancies, in particular, have been associated with macrosomia, oligohydramnios, and declining placental function, all of which may contribute to higher CS rates [14].
Given the rising global concern over high CS rates, understanding the interplay of these risk factors is crucial. This study aims to identify and quantify the risk factors influencing CS rates in nulliparous women undergoing IOL at term, thereby enabling better patient counseling and individualized delivery planning.

Materials 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 study aimed to identify risk factors associated with cesarean delivery in nulliparous women undergoing induction of labour (IOL) at term. All eligible women were recruited after obtaining written informed consent. Cases were defined as women who underwent emergency lower segment cesarean section (LSCS) after IOL, while controls were women who achieved vaginal delivery following IOL.
Inclusion criteria were maternal age between 18–40 years, nulliparity, singleton live pregnancy in vertex presentation, gestational age between 37–42 weeks, and induction of labour using the standard institutional protocol (vaginal misoprostol 25 µg every four hours, up to a maximum of five doses in 24 hours). Exclusion criteria included a scarred uterus (previous cesarean section, myomectomy, or metroplasty), malpresentation, multiple gestation, uterine malformations, contracted pelvis, and multiparity.
All participants underwent detailed history-taking and clinical examination, including assessment of vital signs, systemic examination, and obstetric abdominal examination to determine fetal lie, presentation, and heart rate. Per speculum examination was performed to detect liquor leakage and its characteristics, and per vaginal examination was used to assess pelvic adequacy and calculate the Bishop score. Baseline investigations, including hemoglobin estimation, fasting and postprandial blood glucose levels, and urine routine microscopy, were documented.
Labour induction followed the institutional protocol using vaginal misoprostol 25 µg administered every four hours, with continuous maternal and fetal monitoring through cardiotocography (CTG) and partographic documentation. Once in the active phase of labour, women were managed according to WHO labour care guidelines. Post-delivery, all women were monitored for at least two hours for vital signs, uterine tone, and postpartum bleeding.
Data collected included demographic details, pre-induction Bishop score, indication for induction, antepartum risk factors (maternal age, body mass index, hypertensive disorders, gestational diabetes, post-term pregnancy, IUGR, PROM, oligohydramnios, and estimated birth weight), mode of delivery, neonatal outcomes (birth weight, NICU admission, indications for NICU admission), and maternal complications (postpartum haemorrhage, wound sepsis, thromboembolism, endometritis, hysterectomy, ICU admission, or maternal death).
All participants were followed up until six weeks postpartum to assess composite maternal morbidity, including perineal lacerations, need for blood transfusion, postpartum infections, and thromboembolic events.
Statistical analysis was performed using Epi Info and SPSS version 21.0 (IBM, USA). Quantitative variables were expressed as mean ± standard deviation and compared using independent t-tests, while categorical variables were expressed as frequencies and percentages and compared using the chi-square test. Odds ratios (OR) and adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated to assess the strength of association between risk factors and cesarean delivery. A p-value <0.05 was considered statistically significant.

Results

Maternal Demographic Characteristics

Table 1 presents the baseline demographic and clinical characteristics of the study participants. Women in the cesarean section group (Group A) were significantly older than those in the vaginal delivery group (Group B) (27.09 ± 4.34 vs. 25.00 ± 3.88 years; p = 0.001). The mean BMI was also significantly higher in Group A (24.71 ± 3.37 kg/m²) compared to Group B (22.91 ± 2.17 kg/m²; p = 0.002). The period of gestation at induction was comparable between the two groups (p = 0.10). The pre-induction Bishop score was significantly lower among women in Group A (3.78 ± 0.76) than Group B (4.41 ± 0.95; p = 0.001), indicating less favourable cervical conditions in women who later underwent cesarean section.

Table 1: Maternal Demographic Characteristics

Parameter	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)	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 Labour

Table 2 summarizes the primary indications for induction of labour in both groups. Postdated pregnancy was the most common indication in the vaginal delivery group (41%), whereas hypertensive disorders of pregnancy (28%) and diabetes mellitus (20%) were more prevalent in the cesarean group. The differences in the frequency of postdated pregnancy (p = 0.003), hypertensive disorders (p = 0.004), and diabetes mellitus (p = 0.003) between the groups were statistically significant. Other indications, including intrahepatic cholestasis of pregnancy, PROM, IUGR, decreased fetal movements, and oligohydramnios, did not differ significantly between the groups.

Table 2: Indications for Induction of Labour

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 (Cases)

Table 3 outlines the distribution of specific indications for cesarean delivery in the case group. The most frequent indication was acute fetal distress, accounting for 72% of cesarean deliveries. Failed induction was the second most common indication (19%), followed by non-progression of labour (9%). These findings highlight that intrapartum fetal compromise was the leading contributor to operative intervention after induction in nulliparous women.

Table 3: Indications for Cesarean Section in Group A (Cases)

Indication	N	%
Acute fetal distress	72	72
Failed induction	19	19
Non-progression of labour	9	9
Total	100	100

Neonatal Outcomes

Table 4 presents neonatal outcomes in both study groups. The mean birth weight was slightly higher in the cesarean group (2884.51 ± 366.26 g) compared to the vaginal delivery group (2797.03 ± 369.55 g), though the difference was not statistically significant (p = 0.094). NICU admissions occurred in 15% of neonates in Group A and 12% in Group B (p = 0.680). The primary reason for NICU admission in both groups was neonatal jaundice, followed by respiratory distress syndrome, with no statistically significant difference in the distribution of admission causes.

Table 4: Neonatal Outcomes

Outcome	Group A n (%)	Group B n (%)	p-value
Birth weight (g), mean ± SD	2884.51 ± 366.26	2797.03 ± 369.55	0.094
NICU admission	15 (15.0)	12 (12.0)	0.680
Indication 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 Selected Risk Factors with Cesarean Delivery

Table 5 shows the univariate analysis of selected maternal and obstetric risk factors for cesarean delivery after induction. BMI ≥25 kg/m² (OR = 2.96; p = 0.001), Bishop score <5 (OR = 4.09; p = 0.002), hypertensive disorders of pregnancy (OR = 2.60; p = 0.008), and diabetes mellitus (OR = 2.25; p = 0.040) were significantly associated with higher odds of cesarean delivery. Other factors, including maternal age ≥35 years, PROM, IUGR, oligohydramnios, and birth weight ≥3.5 kg, were not statistically significant predictors, although higher birth weight approached borderline significance (p = 0.070).

Table 5: Association of Selected Risk Factors with Cesarean Delivery

Risk Factor	Group A n (%)	Group B n (%)	OR (95% CI)	p-value
Maternal age ≥35 years	10 (71.4)	4 (28.6)	2.67 (0.807–8.803)	0.163
BMI ≥25 kg/m²	41 (68.3)	19 (31.7)	2.96 (1.564–5.612)	0.001*
Bishop score <5	81 (61.4)	51 (38.6)	4.09 (2.17–7.73)	0.002*
Hypertensive disorders	28 (68.3)	13 (31.7)	2.60 (1.26–5.39)	0.008*
Diabetes mellitus	20 (66.7)	10 (33.3)	2.25 (1.01–5.02)	0.040*
PROM	9 (56.3)	7 (43.8)	1.31 (0.48–3.54)	0.590
IUGR	7 (46.7)	8 (53.3)	0.86 (0.29–2.51)	0.780
Oligohydramnios	1 (33.3)	2 (66.7)	0.49 (0.04–5.48)	0.561
Birth weight ≥3.5 kg	12 (70.6)	5 (29.4)	2.04 (0.93–4.47)	0.070

Discussion

This study evaluated maternal and obstetric risk factors for cesarean delivery following induction of labour (IOL) in nulliparous women at term. Our findings indicate that higher maternal BMI, lower pre-induction Bishop score, hypertensive disorders of pregnancy, and diabetes mellitus

were independent predictors of cesarean delivery after induction.

In the present study, the mean maternal age was significantly higher in the cesarean group compared to the vaginal delivery group. Although maternal age ≥35 years was not a statistically significant predictor in our cohort, other studies have shown advanced maternal age to be an independent risk factor for failed induction and subsequent cesarean delivery due to increased obstetric complications such as preeclampsia, gestational diabetes, and placental abnormalities [15, 16].

BMI ≥25 kg/m² was significantly associated with cesarean delivery in our study. Obesity has been linked to prolonged labour, reduced uterine contractility, and decreased oxytocin receptor sensitivity, contributing to increased operative delivery rates [17, 18]. Vinturache *et al*. reported that obese women were more likely to undergo cesarean after induction, with obesity being an independent risk factor even after adjusting for other variables [19].

The pre-induction Bishop score was another strong predictor of delivery mode. A Bishop score <5 significantly increased the odds of cesarean delivery, consistent with previous studies showing that an unfavourable cervix is associated with prolonged induction-to-delivery intervals and higher failure rates [20, 21]. Laughon *et al*. emphasized that nulliparous women with low Bishop scores at induction are particularly prone to cesarean delivery, regardless of indication [22].

Hypertensive disorders of pregnancy and diabetes mellitus were also significantly associated with cesarean delivery in our study. Similar results were reported by Hawkins *et al*., where gestational diabetes and hypertension were independent predictors of failed induction due to increased fetal compromise and intrapartum complications [23, 24]. In our cohort, acute fetal distress was the leading cause of cesarean section, highlighting the vulnerability of high-risk pregnancies during induction.

Postdated pregnancy was more common in the vaginal delivery group, while medical complications predominated in the cesarean group. This contrasts with findings by Sulaiman *et al*., who reported higher cesarean rates in post-term inductions, suggesting that the interplay of gestational age and cervical status may influence outcomes differently across populations [21].

Neonatal outcomes in our study did not differ significantly between the groups, which is consistent with WHO recommendations that, when indicated, induction is generally safe for the newborn if conducted with appropriate monitoring [25]. NICU admission rates were comparable, and the most common reasons—neonatal jaundice and respiratory distress—were not directly related to the mode of delivery.

Overall, our findings underscore the importance of individualized counselling before induction of labour, especially in nulliparous women with high BMI, low Bishop score, or comorbidities such as hypertension and diabetes. Identifying these risk factors pre-induction allows clinicians to set realistic expectations and adopt strategies such as cervical ripening or closer intrapartum monitoring to improve vaginal delivery rates.

Conclusion

This study found that higher maternal BMI, low pre-induction Bishop score, hypertensive disorders of pregnancy, and diabetes mellitus were significant independent predictors of cesarean delivery following induction of labour in nulliparous women at term, with acute fetal distress being the most common indication for surgery. Although maternal age ≥35 years, PROM, IUGR, oligohydramnios, and higher birth weight showed a tendency toward increased cesarean risk, these were not statistically significant. Neonatal outcomes, including mean birth weight and NICU admission rates, were similar between cesarean and vaginal delivery groups, suggesting that induction, when appropriately indicated and closely monitored, is generally safe for the newborn. Early identification of high-risk women can aid in clinical decision-making, enable tailored cervical ripening strategies, and improve counselling, thereby potentially increasing the likelihood of successful vaginal delivery and reducing unnecessary operative interventions in this population.

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