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Pregnancy outcomes of elective induction in low-risk term pregnancies
A propensity-score analysis

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Abstract

We investigated the mode of delivery and perinatal outcomes in low-risk pregnant women whose labor was electively induced or expectantly managed at term.

Healthy women with viable, vertex singleton pregnancies at 37^{+0} to 40^{+6} weeks of gestation were included. Women electively induced (n = 416) in each week (37^{+0}–37^{+6}, 38^{+0}–38^{+6}, 39^{+0}–39^{+6}, 40^{+0}–40^{+6} weeks) were compared with pregnant women with spontaneous labor (n = 487). The primary outcome was mode of delivery. A propensity score (PS) was derived using logistic regression to model the probability of elective induction group as a function of potential confounders. Altogether, 284 women with elective induction were matched with 284 women who underwent expectant management to create a PS-matched population. All analysis was performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC). All P values reported of the significance level was set at <.05.

There are no significant differences of delivery mode, neonatal intensive care unit (NICU) admission, and neonatal complication between PS-matched groups. Incidence of antepartum complications showed higher in the elective induction group compared to the spontaneous labor group (P = .04). When comparing each gestational week, incidence of NICU admission at 38 weeks in the elective induction group [10/74 (13.5%)] was significantly higher than in and the spontaneous labor group [2/74 (2.7%)] (P = .04).

Elective induction of labor at term is not associated with increased risk of cesarean delivery. However, overall incidence of NICU admission at 38 gestational weeks seems to be increased in elective induction.

Abbreviations: NICU = neonatal intensive care unit, PS = propensity score, RCTs = randomized controlled trials.

Keywords: cesarean delivery, elective induction of labor, pregnancy, propensity score analysis

1. Introduction

Induction of labor is a common obstetrical intervention with an incidence of 20% to 25% of pregnancies.[1] There are medical indications for labor induction such as hypertensive diseases, maternal chronic diseases, fetal growth restriction, oligohydramnios, post-term pregnancy, and so on. Elective induction of labor is defined as an induction without any medical indications in healthy pregnant women and some experts suggested terminology of non-medically indicated inductions instead of elective induction.[2,3] Elective induction could be considered with specific situations including geographical remoteness from the hospital, fatigue or discomfort associated with pregnancy, concerns that awaiting unexpectedly rapid labor and concerns about maternal or perinatal complications associated with continuing pregnancy.[4] Elective induction of labor is a still debatable issue, and the relationship between elective induction of labor and the risk of cesarean delivery is not clear. It had been considered like a dogma that elective induction increased the risk of cesarean delivery.[5,6] However, recent researches demonstrated unchanged or decreased risk of cesarean delivery and maternal and fetal morbidity with elective induction compared to expectant management.[7,8] The reasons for these controversial results of existing literature could be different approaches of methods, different comparison groups, data sources, or gestational age. In Korea, in the absence of clear guidelines and recommendation of elective induction of labor, the use of elective induction varies according to the policy of each hospital.

The purpose of this study was to evaluate the benefits and harms of elective induction of labor in low-risk pregnant women using propensity score (PS) analysis.

2. Materials and methods

A total of 1,977 pregnant women whose delivery was carried out between January 2016, and November 2016, at Bundang CHA medical center, Korea were included and retrospectively analyzed. The approval was obtained from the Institutional Review Board of Bundang CHA medical center (CHAMC 2018–03–018).

Healthy pregnant women with viable, vertex singleton pregnancies at 37^{+0} to 41^{+6} weeks of gestation were included. We excluded pregnant women who delivered before 37 weeks or after 42 weeks, and women with prior cesarean section or previous uterine operation, multiple pregnancies, pregnancies with elective cesarean section and fetal anomalies were also excluded. There were 903 pregnant women who delivered between 37^{+0} and 41^{+6} weeks of gestational ages, of which 416 patients underwent elective induction of labor and 487 were admitted with spontaneous labor or pre-labor rupture of membrane. Elective labor induction was conducted by pre-induction cervical ripening followed by oxytocin infusion in cases of unfavorable cervix or by oxytocin only in cases of favorable cervix. Bishop score was recorded at the time of admission.

We compared women who underwent elective labor induction and spontaneous labor or pre-labor rupture of membrane in each gestational week (37^{+0}–37^{+6}, 38^{+0}–38^{+6}, 39^{+0}–39^{+6}, 40^{+0}–40^{+6} weeks). The primary outcome was mode of delivery, and the secondary outcomes were neonatal intensive care unit (NICU) admission, antepartum complications such as postpartum

Table 1

Clinical characteristics in the overall population and the PS-matched population.

Variable	Overall population				PS- matched Population			
	Elective induction (N=416)	Spontaneous labor (N=487)	P value	STD	Elective induction (N=284)	Spontaneous labor (N=284)	P value	STD
Age, yr	33.97±3.85	33.31±3.9	.011	0.170	33.58±3.67	33.7±3.79	.698	0.031
Height,cm	162.13±4.72	161.88±4.87	.430	0.053	162.18±4.67	162.17±4.92	.987	0.001
Weight,kg	70.73±10.45	67.94±9.07	<.001	0.285	69.5±10.03	68.98±8.85	.485	0.055
BMI, kg/m^2	26.86±3.64	25.92±3.28	<.001	0.271	26.39±3.49	26.25±3.25	.616	0.041
Parity, primi	322 (77.4)	350 (71.87)	.068	0.127	206 (72.54)	204 (71.83)	.924	0.016
Abortion history, >1	154 (37.02)	135 (27.78)	.004	0.198	90 (31.69)	89 (31.34)	1	0.008
Gestational age at delivery	39.13±1.11	39±1.09	.084	0.116	39.05±1.12	38.98±1.07	.448	0.063
Instrumental delivery	13 (4.38)	69 (16.63)	<.001	0.408	9 (3.96)	39 (16.74)	<.001	0.429
Indications of cesarean section			.042				.343	
CPD	41 (31.06)	34 (40.96)		0.207	22 (31.88)	26 (41.94)		0.209
Fetal distress	44 (33.33)	30 (36.14)		0.059	27 (39.13)	21 (33.87)		0.109
Progression failure	45 (34.09)	15 (18.07)		0.371	18 (26.09)	11 (17.74)		0.203
Multiple indication	2 (1.52)	4 (4.81)		0.133	2 (2.9)	4 (6.45)		0.101
Epidural anesthesia	245 (58.89)	327 (67.15)	.013	0.172	188 (66.2)	183 (64.44)	.709	0.037
Bishop score	3.2±0.88	4.41±1.86	<.001	0.828	3.44±0.89	3.49±0.96	.170	0.057
Interval of admission to discharge, days	3.31±1.21	2.90±1.09	<.001	0.358	3.1±1.05	3.0±1.04	.293	0.087
Amniotic fluid, normal	399 (95.91)	451 (92.61)	.049	0.142	270 (95.07)	271 (95.42)	1	0.017
Placental weight,g	693.29±146	681.93±135.24	.228	0.081	688.52±149.15	682.69±137.75	.630	0.041
Episiotomy			<.001				.671	
Median	173 (41.59)	247 (52.45)		0.189	128 (45.07)	137 (50.37)		0.084
RML	110 (26.44)	153 (32.48)		0.133	86 (30.28)	83 (30.51)		0.005
No episiotomy	0 (0)	2 (0.42)		0.092	0 (0)	1 (0.37)		0.086
Laceration			.055				.362	
No	1 (0.35)	1 (0.25)		0.019	0 (0)	1 (0.45)		0.096
1st	0 (0)	2 (0.5)		0.1	0 (0)	2 (0.91)		0.135
2nd	266 (93.99)	364 (90.55)		0.129	201 (94.37)	199 (90.45)		0.148
3rd	14 (4.95)	35 (8.71)		0.149	10 (4.69)	18 (8.18)		0.142
4th	2 (0.71)	0 (0)		0.119	2 (0.94)	0 (0)		0.138
Uterotonic agent			.139				.894	
No	134 (26.8)	121 (21.04)		0.135	76 (21.53)	81 (24.92)		0.080
Duratocin	253 (50.6)	332 (57.74)		0.144	191 (54.11)	176 (54.15)		0.001
Nalador	45 (9)	44 (7.65)		0.049	36 (10.2)	19 (5.85)		0.161
Misoprostol	42 (8.4)	46 (8)		0.015	35 (9.92)	22 (6.77)		0.114
Erubin	26 (5.2)	32 (5.57)		0.016	15 (4.25)	27 (8.31)		0.168
Gender, male	212 (50.96)	263 (54)	.398	0.061	137 (48.24)	154 (54.23)	.187	0.120
Birth.weight, g	3235.65±406.75	3162.76±357.86	.005	0.190	3193.13±413.28	3173.36±366	.526	0.051
APGAR.1 min	7 (7-9)	7 (7–9)	.309	0.067	7 (7–9)	7 (7–9)	.814	0.020
APGAR.5 min	8 (8–10)	8 (8–10)	.121	0.101	8 (8–10)	8 (8–10)	.517	0.055
Nursery admission period, days	3.26±1.34	2.95±1.25	.001	0.244	3.04±1.2	3.15±1.34	.334	0.085
NICU.admission period, days	8.76±4.61	14.87±24.1	.133	0.019	9.0±1.41	9.5±2.12	.500	0.277
Maternal complication			.137				1	
No	359 (86.3)	437 (89.73)		0.106	251 (88.38)	251 (88.38)		0
Yes	57 (13.7)	50 (10.27)		0.106	33 (11.62)	33 (11.62)		0
Pregnancy related complication			.004				.041	
No	409 (98.32)	487 (100)		0.185	278 (97.89)	284 (100)		0.208
Yes	7 (1.68)	0 (0)		0.185	6 (2.11)	0 (0)		0.208

Mean±SD, N (%).

BMI=body mass index, CPD=cephalopelvic disproportion, NICU=neonatal intensive care unit, RML=right medio-lateral

hemorrhage (PPH), vaginal wall hematoma, placental abruption and neonatal complications such as asphyxia, respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), necrotizing enterocolitis (NEC), and sepsis.

For statistical processing, the Chi-square test or Fisher exact test was used for categorical variables and the Two-sample t test or the Wilcoxon Rank Sum Test was used for continuous variables. A PS was derived using logistic regression to model the probability of elective induction group as a function of potential confounders. Altogether, 284 women with elective induction were matched with 284 women who underwent expectant management to create a propensity-score-matched population. All analysis was performed using SAS software, version 9.4 (SAS Institute, Inc., Cary, NC). All P value reported of the significance level was set at $<.05$.

3. Results

Total of 903 pregnant women was included in this study. After applying a PS-matching procedure, 284 patients who underwent elective labor induction were matched to 284 patients who had spontaneous labor. The PS-matching process further improved balance of the clinical characteristics between the elective labor induction and the spontaneous labor group (Table 1). Significant differences were observed between the elective induction group and the spontaneous labor group in terms of instrumental delivery ($P <.001$) and incidence of pregnancy-related complications ($P <.041$) in PS-matched population.

Pregnancy outcomes between 2 groups were evaluated among the overall and PS-matched population (Table 2). There were statistically significant differences of delivery mode between the

elective induction group and the spontaneous labor group in overall population ($P <.001$), but there were no significant differences of delivery mode in PS-matched population ($P=.538$). The incidence of NICU admission and neonatal complications was not significantly different among the overall and the PS-matched population. The incidence of antepartum complications was higher in elective the induction group compared to the spontaneous labor group ($P=.041$). When comparing each gestational week in the overall population, there was significant difference in the mode of delivery between the 39^{+0} to 39^{+6} group ($P <.001$) and the 40^{+0} plus group ($P=.002$, Table 3). However, we found no difference in the incidence of Cesarean section between 2 groups in the PS-matched population.

The incidence of NICU admission was not different in the overall population according to gestational weeks, the incidence of NICU admission of the 38^{+0}–38^{+6} group in the elective induction group [10/74 (13.5%)] were significantly higher than the spontaneous labor group [2/74 (2.7%)] ($P=.043$). There were no significant differences in antepartum and neonatal complications in 2 groups in the overall and the PS-matched population.

4. Discussion

This study compared maternal and perinatal outcomes between the elective induction group and the spontaneous labor group. We did not find significant differences of complications between 2 groups in the PS-matched population. This study showed that elective induction did not increase the risks of cesarean delivery, regardless of weeks of gestation, cervical status, and parity. Furthermore, the comparison of maternal and neonatal outcomes

Table 2

Pregnancy outcomes between study groups among the overall population and the PS-matched population.

Variable	Before PSM			After PSM		
	Elective induction (N=416)	Spontaneous labor (N=487)	P value	Elective induction (N=284)	Spontaneous labor (N=284)	P value
Delivery mode						
Vaginal delivery	284 (68.27)	404 (82.96)	<.001	215 (75.7)	222 (78.17)	.538
Cesarean section	132 (31.73)	83 (17.04)		69 (24.3)	62 (21.83)	
NICU admission						
No	379 (91.10)	448 (92)	.568	258 (90.84)	269 (94.72)	.100
Yes	37 (8.90)	39 (8)		26 (9.16)	15 (5.28)	
Indications of NICU admission						
Transient tachypnea of Newborn, tachycardia	12	13		10	5	
Respiratory distress syndrome,	2	3		2	1	
Meconium aspiration syndrome						
Birth asphyxia, birth injury	2	4		1	2	
Seizure, hypotonia	4	1		2	0	
Congenital anomaly	7	5		5	2	
Maternal disease	0	7		0	3	
Jaundice	5	2		3	1	
Sepsis	1	1		0	0	
Poor oral intake	2	3		1	1	
Small for gestational age	2	0		2	0	
Antepartum complications						
No	409 (98.32)	487 (100)	.004	278 (97.89)	284 (100)	.041
Yes	7 (1.68)	0 (0)		6 (2.11)	0 (0)	
Neonatal complications						
No	385 (92.55)	443 (90.97)	.460	259 (91.2)	257 (90.49)	.883
Yes	31 (7.45)	44 (9.03)		25 (8.8)	27 (9.51)	

NICU = neonatal intensive care unit.

Table 3

Comparison of clinical outcomes according to gestational age at delivery between the overall population and the PS-matched population.

Overall population

Gestational age at delivery (weeks)

Variable	37+0~37+6			38+0~38+6			39+0~39+6			40+0~40+6		
	Study	Control	P value	Study	Control	P value	Study	Control	P value	Study	Control	P value
Delivery mode, n (%)												
Vaginal delivery	50 (72.46)	68 (79.07)	.442	79 (73.15)	105 (82.68)	.108	78 (67.24)	152 (85.39)	<.001	76 (62.3)	79 (82.29)	.002
Cesarean section	19 (27.54)	18 (20.93)		29 (26.85)	22 (17.32)		38 (32.76)	26 (14.61)		46 (37.7)	17 (17.71)	
Total	69 (100)	86 (100)		108 (100)	127 (100)		116 (100)	178 (100)		122 (100)	96 (100)	
NICU admission, n (%)												
No	58 (86.57)	66 (82.5)	.654	95 (88.79)	116 (92.8)	.405	102 (91.07)	168 (95.45)	.212	115 (95.04)	89 (93.68)	.894
Yes	9 (13.43)	14 (17.5)		12 (11.21)	9 (7.2)		10 (8.93)	8 (4.55)		6 (4.96)	6 (6.32)	
Total	67 (100)	80 (100)		107 (100)	125 (100)		112 (100)	176 (100)		121 (100)	95 (100)	
Antepartum.complication, n (%)												
No	67 (97.1)	86 (100)	.197	106 (98.15)	127 (100)	.210	115 (99.14)	178 (100)	.395	120 (98.36)	96 (100)	.505
Yes	2 (2.9)	0 (0)		2 (1.85)	0 (0)		1 (0.86)	0 (0)		2 (1.64)	0 (0)	
Total	69 (100)	86 (100)		108 (100)	127 (100)		116 (100)	178 (100)		122 (100)	96 (100)	
Neonatal.complication, n (%)												
No	63 (91.3)	69 (80.23)	.089	104 (96.3)	115 (90.55)	.138	104 (89.66)	168 (94.38)	.201	113 (92.62)	91 (94.79)	.711
Yes	6 (8.7)	17 (19.77)		4 (3.7)	12 (9.45)		12 (10.34)	10 (5.62)		9 (7.38)	5 (5.21)	
Total	69 (100)	86 (100)		108 (100)	127 (100)		116 (100)	178 (100)		122 (100)	96 (100)	

PS-Matched population

Gestational age at delivery (weeks)

Variable	37+0~37+6			38+0~38+6			39+0~39+6			40+0~40+6		
	Study	Control	P value	Study	Control	P value	Study	Control	P value	Study	Control	P value
Delivery mode												
Vaginal delivery	41 (78.85)	39 (75)	.789	59 (77.63)	62 (81.58)	.663	60 (72.29)	69 (83.13)	.066	39 (76.47)	40 (78.43)	1
Cesarean section	11 (21.15)	13 (25)		17 (22.37)	14 (18.42)		23 (27.71)	14 (16.87)		12 (23.53)	11 (21.57)	
Total	52 (100)	52 (100)		76 (100)	76 (100)		83 (100)	83 (100)		51 (100)	51 (100)	
NICU admission, n (%)												
No	40 (86.96)	41 (89.13)	1	64 (86.49)	72 (97.3)	.043	70 (89.74)	76 (97.44)	.114	48 (96)	48 (96)	1
Yes	6 (13.04)	5 (10.87)		10 (13.51)	2 (2.7)		8 (10.26)	2 (2.56)		2 (4)	2 (4)	
Total	46 (100)	46 (100)		74 (100)	74 (100)		78 (100)	78 (100)		50 (100)	50 (100)	
Antepartum.complication, n (%)												
No	50 (96.15)	52 (100)	.479	75 (98.68)	76 (100)	1	83 (100)	83 (100)	1	50 (98.04)	51 (100)	1
Yes	2 (3.85)	0 (0)		1 (1.32)	0 (0)		0 (0)	0 (0)		1 (1.96)	0 (0)	
Total	52 (100)	52 (100)		76 (100)	76 (100)		83 (100)	83 (100)		51 (100)	51 (100)	
Neonatal.complication, n (%)												
No	47 (90.38)	41 (78.85)	.181	73 (96.05)	68 (89.47)	.182	73 (87.95)	76 (91.57)	.579	47 (92.16)	49 (96.08)	.683
Yes	5 (9.62)	11 (21.15)		3 (3.95)	8 (10.53)		10 (12.05)	7 (8.43)		4 (7.84)	2 (3.92)	
Total	52 (100)	52 (100)		76 (100)	76 (100)		83 (100)	83 (100)		51 (100)	51 (100)	

NICU = neonatal intensive care unit.

according to the gestational weeks from 37^{+0} to 40^{+6} didn't show any statistically significant differences, except for the higher NICU admission rate among the gestational weeks from 38^+ to 38^{+6} in the elective induction group.

There has been debate surrounding the safety of elective induction for long time. It is unsurprising that there were controversial conclusions in previous studies regarding the risk of adverse maternal and perinatal outcomes, including the risk of cesarean section.[9,10] For decades, other studies have revealed that labor induction was associated with the increased risk of cesarean section, and cesarean delivery in the current pregnancy could affect to increase both maternal and neonatal complication in the next pregnancies.[11] However, more recent randomized controlled trials (RCTs) have reported that cesarean delivery rate was not increased or decreased in the labor induction group compared to the expectant management group.[12,13] A few studies have argued that elective induction can be used safely in special situations.[14,15] Our finding of no increase of cesarean delivery rate with elective induction is consistent with the results of recent researches.

These discrepancies among studies can be attributed to the effect of flawed methodologies. Stock et al[16] reported that there was no increased rate of cesarean delivery between pregnant women with elective labor induction and with expectant management, but they did not consider about bishop score of cervix nor analyze outcomes by parity. In 2009, previous prospective cohort study reported that cervix status and parity were important factors to affect the cesarean section rate with term pregnancies.[17] Gibson et al[18] evaluated the mode of delivery and maternal and neonatal outcomes in pregnant women with elective labor induction and expectant management at low-risk term pregnancies. Elective labor induction at term was associated with decreased rate of cesarean delivery and maternal and neonatal morbidities regardless of cervical status and parity.

Previous studies were mostly retrospective when they compared elective labor induction and expectant management.[19] There were few RCTs, but there are not many well-designed or adequately powered studies.[14,20,21] There can be many differences in the labor induction medication and protocols, and this can lead to controversial results according to the timing of the study or the institute. Our study, however, is a comparison of elective induction and spontaneous labor in a single institute, where standardization of labor management and consistent labor induction protocol is established, during 1-year period. A randomized clinical trial of a larger scale, using prospectively collected data from a well-characterized trial cohort, is ideal and necessary to validate the findings of this study but pregnancy is a sensitive situation that causes anxiety, and therefore, clinical trials maybe impractical. Our institute's management protocol uses as little external intervention as possible, thereby simulating a hypothetical randomized trial.[22] Also, we used a PS-matched method to obtain the results that exclude confounding variables.[23] All mentioned methodologies were used to minimize bias, therefore the results are more reliable even though this is a retrospective study.

Recent studies about elective induction have focused on the increase of cesarean delivery risk and maternal and neonatal outcome as the study outcome. However, previous study reported that labor induction group showed longer maternal hospital length of stay (10 h) than the expectant management group.[24] In this study, interval of admission to discharge was significantly longer in the elective induction group than in the spontaneous labor group for the overall population. In addition,

pregnant women expectantly managed would be visiting emergency clinic or labor and delivery room more frequently than those electively induced. Future researches should also consider the stress and anxiety of the obstetrician and the burden of work such as the length of hospital stay and the frequency of hospital. In addition, the potential risks of elective induction need to be weighed against the risks for dissatisfied experience of pregnant women and cost/resource use.

In conclusion, elective induction between 37^{+0} and 40^{+6} weeks of gestation is not strongly associated with an increased risk of Cesarean delivery and poor maternal and neonatal morbidity. However, incidence of NICU admission at 38 gestational weeks seems to be increased in elective induction in PS-matched population.

Author contributions

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