

Original Article
Obstetrics & Gynecology



Risk of Emergency Operations, Adverse Maternal and Neonatal Outcomes according to the Planned Gestational Age for Cesarean Delivery

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OPEN ACCESS

Received: Oct 1, 2017
Accepted: Dec 4, 2017

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ABSTRACT

Background: The objective of this study was to assess the risk of emergency cesarean deliveries (CDs) and adverse neonatal/maternal outcomes according to the planned gestational age at delivery (GAD) for elective CD.

Methods: The study population consisted of term singleton pregnant women who were booked for elective CD and were subsequently delivered at term by CD, after excluding cases with a trial of labor. The relationship between the planned GAD, risk of emergency CD prior to planned date, and adverse neonatal/maternal outcomes were determined.

Results: The frequency of emergency CD, adverse neonatal and maternal outcomes were 9.5%, 4.5%, and 5.9%, respectively. The risk of emergency CD prior to the planned delivery date increased significantly according to the planned GAD (5.8% at 37 weeks, 8.2% at 38 weeks, 13.6% at 39 weeks, and 26.7% at 40 weeks or more of planned GAD, $P = 0.005$). Emergency CD was associated with an increased risk of adverse maternal outcomes, whereas the risk of adverse neonatal outcomes did not differ. In the total study population including both cases with elective and emergency CD, the risk of adverse maternal outcomes did not increase according to the planned GAD, and the risk of adverse neonatal outcomes decreased significantly according to the planned GAD.

Conclusion: The risk of emergency CD increased as the planned GAD increased, but the risk of adverse maternal outcomes did not increase and the risk of adverse neonatal outcomes decreased significantly according to the planned GAD in the total study population including elective/emergency CD.

Keywords: Cesarean Delivery; Maternal Morbidity; Neonatal Outcome; Emergency Cesarean Delivery; Planned Gestational Age at Delivery

INTRODUCTION

Early term delivery, defined as term delivery at 37–38 weeks of gestation, has been reported to be associated with the risk of neonatal morbidity, and this relationship has also been demonstrated in cases with elective cesarean delivery (CD).¹⁻⁵ According to these evidences, it has been recommended to postpone elective CD until late term (39 weeks of gestation or later).⁶ Planning the date of elective CD in the late term period may increase the risk of emergent CD,

Funding

This research was supported by the Bio & Medical Technology Development Program of the National Research Foundation (NRF) funded by the Ministry of Science and ICT of Korea (2016M3A9B6902061).

Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Lee SM, Park JS. Data curation: Lee SM, Kim SA, Ahn JH, Youm J. Formal analysis: Lee SM, Park JS, Jung YM. Investigation: Lee SM, Park JS, Kim SA, Ahn JH, Youm J, Park CW, Jun JK. Validation: Lee SM, Jung YM, Park JS. Writing - original draft: Lee SM, Park JS. Writing - review & editing: Lee SM, Park JS, Jung YM, Kim SA, Ahn JH, Youm J, Park CW, Jun JK.

which could be a risk factor for maternal/neonatal morbidity. Nevertheless, most studies of adverse neonatal outcomes and the timing of CDs are based on elective CDs after excluding cases with emergent CD.^{2,7-9}

To address this issue, we assessed the risk of emergent CD prior to the planned delivery date and adverse neonatal/maternal outcomes according to the planned gestational age at delivery (GAD) for elective CD.

METHODS**Study design**

The study population consisted of consecutive term pregnant women who were booked for elective CD and were subsequently delivered at term (gestational age at or after 37 weeks) in Seoul National University Hospital between January 2003 and February 2011. In this study period when the conception of early term deliveries has not been universally implemented, the delivery timing was decided at the discretion of the attending obstetrician based on the mother's preference. Cases in which a trial of labor was undertaken prior to CD, cases in which the elective dating of CD was not completed, cases of fetal anomaly or fetal death in utero, cases with maternal disease that could affect the fetal outcome (hypertensive disease in pregnancy, gestational diabetes requiring insulin therapy, overt diabetes, history of maternal cardiac/renal/connective tissues disease, human immunodeficiency virus [HIV] infection, clinical chorioamnionitis prior to delivery, active rhesus or other blood type antagonism, and maternal infectious disease such as toxoplasmosis, syphilis, rubella, cytomegalovirus, or herpes), or cases with an obstetric condition that could affect the fetal outcome (non-reassuring fetal status, placenta previa, placenta accreta, placental abruption, nonvertex presentation with unsuccessful version) were excluded.

The relationship between the planned GAD for elective CD (planned GAD), the rate of emergent CD due to labor/ruptured membranes prior to the planned delivery date, and the risk of adverse neonatal/maternal outcomes were determined in the study population.

Adverse neonatal and maternal outcomes

Adverse neonatal outcomes were defined as the presence of neonatal mortality, adverse respiratory outcomes (respiratory distress syndrome, transient tachypnea of newborn, or need for respiratory assistant such as continuous positive airway pressure or ventilator), proven congenital sepsis, hypoglycemia, seizures, necrotizing enterocolitis, hypoxic ischemic encephalopathy, cardiopulmonary resuscitation, 5-minute Apgar Score ≤ 3 , admission to the neonatal intensive care unit (NICU), or prolonged hospitalization for more than 10 days. The criteria for adverse neonatal outcomes were adapted from the criteria of Tita et al.² and Gartey et al.¹ with modification.

Adverse maternal outcomes included a primary composite of death, uterine atony, need for transfusion, uterine artery embolization, peripartum hysterectomy, cystostomy, broad ligament hematoma, uterine artery ligation, uterine rupture, wound dehiscence, admission to the intensive care unit, endometritis, thromboembolic complications, or postoperative ileus. The criteria for adverse maternal outcomes were adapted from the criteria of Tita et al.¹⁰ with modification.

Statistical analysis

Proportions were compared with Fisher's exact test, and comparisons of continuous variables between groups were performed with a Mann-Whitney U test or Kruskal-Wallis analysis of variance as appropriate. Logistic regression analysis was conducted for multivariate analysis. P values < 0.05 were considered significant.

Ethics statement

The Institutional Review Board of the Seoul National University Hospital approved the study, and we followed the ethical standards for human experimentation established in the Declaration of Helsinki.

RESULTS

Study population

During the study period, a total of 1,915 singleton pregnant women delivered term neonates (≥ 37 weeks of gestation) by cesarean section. After excluding cases in which a trial of labor was undertaken ($n = 359$), cases with fetal anomaly or fetal death in utero ($n = 140$), cases with maternal disease that could affect the fetal outcome ($n = 186$), cases with an obstetric condition that could affect the fetal outcome ($n = 172$), cases in which the elective dating of CD was not completed ($n = 12$), and cases with incomplete medical records ($n = 11$), the remaining 1,035 cases were included in the analysis. Among these 1,035 women, 937 patients were delivered on the planned delivery date by elective operation, whereas 98 women underwent emergency CD prior to planned delivery date due to the onset of labor or ruptured membranes.

Adverse neonatal/maternal outcomes in elective CD

In the total study population of 1,035 women, 103 women were scheduled for elective CD at 37–37⁺⁶ weeks of gestation, 681 women at 38–38⁺⁶ weeks, 236 women at 39–39⁺⁶ weeks, and 15 women at 40 weeks of more. Among these women, 937 (90.5%) were delivered by elective CD on the planned delivery date. The relationship between the GAD and risk of adverse neonatal/maternal outcomes were determined in these 937 women with elective CD. As shown in **Table 1**, the risk of adverse neonatal outcomes decreased significantly with advancing GAD. The rate of adverse maternal outcomes did not differ according to the GAD. The association between the GAD and adverse neonatal outcomes remained significant after adjustment for indication of CD and small for gestational age ($P < 0.01$).

The risk of emergency operation according to the planned GAD and adverse neonatal/maternal outcomes

In the total study population of 1,035 women, 98 women (9.5%) were delivered by emergent CD prior to the planned delivery date. **Fig. 1** shows the risk of emergent CD according to the planned GAD, and the risk of emergent delivery increased significantly with increasing planned GAD.

Table 2 compares the clinical characteristics and the risk of adverse neonatal/maternal outcomes between cases of elective CD ($n = 937$) and cases of emergent CD ($n = 98$). Women undergoing emergent CD had a greater planned GAD than those undergoing elective CD (the mean planned GAD: 38.8 weeks in cases of emergent CD vs. 38.5 weeks in cases of elective CD, $P < 0.001$). The risk of adverse neonatal outcomes did not differ by the type of

Risk by Planned Gestational Age of Cesarean Delivery

Table 1. Clinical characteristics and adverse neonatal/maternal outcomes according to the GAD among women who were delivered by elective CD

Characteristics	37–37 ⁺⁶ wk (n = 97)	38–38 ⁺⁶ wk (n = 625)	39–39 ⁺⁶ wk (n = 204)	≥ 40 wk (n = 11)	P ^a	P ^b
Maternal characteristics						
Maternal age, yr	33 ± 4	33 ± 4	34 ± 4	32 ± 3	NS	NS
Married ^c	91/92 (98.9)	590/592 (99.7)	197/197 (100)	10/10 (100)	NS	NS
Nulliparity ^c	25 (26)	173 (28)	72 (35)	5 (46)	0.098	0.086
Indication for CD^c						
Previous CD	66 (68)	425 (68)	112 (55)	4 (36)	< 0.001	< 0.001
Malpresentation	13 (13)	97 (16)	58 (28)	4 (36)		
Previous uterine surgery	9 (9)	61 (10)	12 (6)	0 (0)		
Others	9 (9)	42 (7)	22 (11)	3 (27)		
Neonatal characteristics						
Male ^c	50 (52)	302 (48)	103 (51)	4 (36)	NS	NS
Birthweight, g	3,168 ± 340	3,208 ± 353	3,357 ± 419	3,578 ± 452	< 0.001	< 0.001
Small for gestational age ^c	1 (1)	19 (3)	11 (5)	0 (0)	NS	NS
Adverse neonatal outcomes^d						
Any adverse outcome or death	10 (10.3)	25 (4.0)	6 (2.9)	0 (0)	< 0.010	< 0.050
Mortality	0 (0)	0 (0)	0 (0)	0 (0)	-	-
RDS or TTN	1 (1.0)	5 (0.8)	0 (0)	0 (0)	NS	NS
Need for respiratory assistant such as CPAP or ventilator	2 (2.1)	3 (0.5)	0 (0)	0 (0)	< 0.050	< 0.050
Proven sepsis	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hypoglycemia (< 35 mg/dL)	0 (0)	2 (0.3)	0 (0)	0 (0)	NS	NS
Admission to the NICU	5 (5.2)	5 (0.8)	3 (1.5)	0 (0)	0.073	0.080
5-min Apgar score ≤ 3	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hospitalization > 10 day	8 (8.2)	17 (2.7)	4 (2.0)	0 (0)	< 0.050	< 0.050
Adverse maternal outcomes^d						
Any adverse outcome or death	4 (4.1)	37 (5.9)	9 (4.4)	0 (0)	NS	NS
Death	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Uterine artery embolization	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hysterectomy	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Cystostomy	0 (0)	3 (0.5)	2 (1.0)	0 (0)	NS	NS
Uterine artery ligation	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Transfusion	4 (4.1)	24 (3.8)	3 (1.5)	0 (0)	NS	NS
Atony	0 (0)	9 (1.4)	4 (2.0)	0 (0)	NS	NS
Uterine rupture	0 (0)	1 (0.2)	0 (0)	0 (0)	NS	NS
Wound dehiscence	0 (0)	2 (0.3)	0 (0)	0 (0)	NS	NS
Admission in the intensive care unit	0 (0)	1 (0.2)	0 (0)	0 (0)	NS	NS
Endometritis	0 (0)	1 (0.2)	0 (0)	0 (0)	NS	NS
Thromboembolic complication	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Postoperative ileus	0 (0)	2 (0.3)	1 (0.5)	0 (0)	NS	NS

Data are shown as mean ± standard deviation or number (%).

GAD = gestational age at delivery, CD = cesarean delivery, RDS = respiratory distress syndrome, TTN = transient tachypnea of newborn, CPAP = continuous positive airway pressure, NICU = neonatal intensive care unit, NS = not significant.

^aP tested for total; ^bP tested from 37 to 39 weeks only; ^cAnalyzed by χ^2 test; ^dAnalyzed by χ^2 test for trend.

CD (elective vs. emergent). However, women who underwent emergent CD had a greater risk of adverse maternal outcomes than those who underwent elective CD and this relationship between emergent CD and adverse maternal outcomes remained significant after adjustment for the maternal age, GAD, and indication for CD (Table 3).

Adverse neonatal/maternal outcomes in total study population including both cases with elective and emergency CD

The relationship between the planned GAD and risk of adverse neonatal/maternal outcomes were determined in total study population including both cases with elective cesarean and emergency CD. As shown in Table 4, the risk of adverse neonatal outcomes decreased significantly with advancing planned GAD. The rate of adverse maternal outcomes did not differ according to the planned GAD (P = not significant).

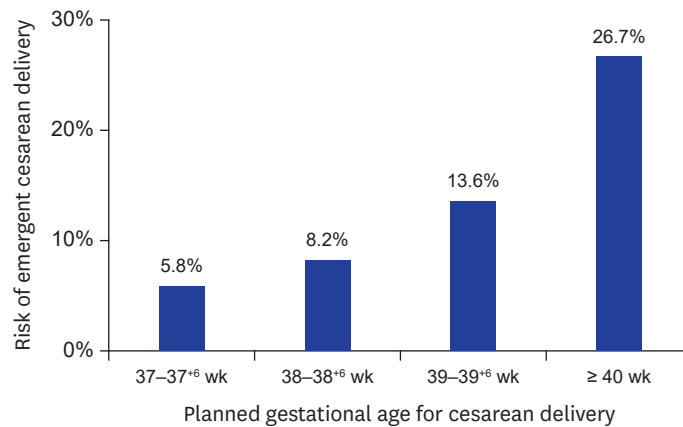


Fig. 1. The risk of emergent cesarean delivery according to the planned gestational age at delivery. $P = 0.005$ by χ^2 test for trend.

DISCUSSION

The main findings of the current study were: 1) the risk of emergent operation increased significantly with increasing planned GAD for elective CD; 2) the risk of adverse maternal outcomes was greater in cases of emergent CD compared to elective CD, whereas the risk of adverse neonatal outcomes did not differ; 3) in the total study population including both cases with elective and emergency operation, the risk of adverse maternal outcomes did not increase according to the planned GAD, and the risk of adverse neonatal outcomes decreased significantly according to the planned GAD.

To our knowledge, this is the first study which assessed the risk of emergency CDs and adverse neonatal/maternal outcomes according to the planned GAD for elective CDs. Indeed, most studies of adverse neonatal or maternal outcomes and the timing of CDs are based on elective CDs after excluding cases with emergent CD.

Previous studies have indicated that the risk of adverse neonatal outcomes in elective term CDs decreases progressively with increasing gestational age at birth.^{2,7-9,11} According to this evidence, performing elective CD prior to 39 weeks of gestation is discouraged. However, delaying delivery until 39 weeks may increase the risk of emergent CDs, and the outcome of this particular group has not been adequately addressed in the literature.¹² In the current study, we examined the frequency and risk among this group undergoing emergent delivery with regards to both neonatal and maternal outcomes. As a result, the risk of emergency operation was increased in cases according to advance planned GAD, and maternal morbidity was higher in cases with emergency CD. However, the total risk of adverse maternal outcomes did not increase according to the advance planned GAD, when including both cases with elective and emergent CD, and the total risk of adverse neonatal outcomes decreased significantly according to the advanced planned GAD.

In the literature, the impacts of emergent CD on adverse neonatal outcomes in patients who are candidates for elective CDs are controversial. Neonatal respiratory morbidity has been shown to decrease in cases of emergent CD after the onset of labor,^{3,13,14} although other studies have failed to demonstrate this relationship.^{11,15} In addition, the onset of labor in cases among women who have undergone previous cesarean is associated with lower cord pH, neonatal

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Table 2. Clinical characteristics and adverse neonatal/maternal outcomes between cases of elective CD and cases of emergent CD

Characteristics	Elective CD (n = 937)	Emergent CD (n = 98)	P
Mean planned GAD, wk	38.5 ± 0.6	38.8 ± 0.7	< 0.001
Planned GAD			< 0.010
37–37 ⁶ wk	97 (10)	6 (6)	
38–38 ⁶ wk	625 (67)	56 (57)	
39–39 ⁶ wk	204 (22)	32 (33)	
≥ 40 wk	11 (1)	4 (4)	
GAD, wk	38.5 ± 0.6	38.2 ± 0.7	< 0.001
Maternal characteristics			
Maternal age, yr	33 ± 4	34 ± 4	NS
Married	888/891 (99.7)	92/93 (98.9)	NS
Nulliparity	275 (29)	30 (31)	NS
Indications for CD			NS
Previous CD	607 (65)	57 (58)	
Malpresentation	172 (18)	26 (27)	
Previous uterine surgery	82 (9)	8 (8)	
Other	76 (8)	7 (7)	
Neonatal characteristics			
Male	459 (49)	52 (53)	NS
Birthweight, g	3,241 ± 375	3,134 ± 420	< 0.050
Small for gestational age	31 (3)	7 (7)	0.081
Adverse neonatal outcomes			
Any adverse outcome or death	41 (4.4)	6 (6.1)	NS
Mortality	0 (0)	0 (0)	-
RDS or TTN	6 (0.6)	1 (1.0)	NS
Need for respiratory assistant such as CPAP or ventilator	5 (0.5)	0 (0)	NS
Proven sepsis	0 (0)	0 (0)	-
Hypoglycemia (< 35 mg/dL)	2 (0.2)	1 (1.0)	NS
Admission to the NICU	13 (1.4)	3 (3.1)	NS
5-min Apgar score ≤ 3	0 (0)	0 (0)	-
Hospitalization > 10 day	29 (3.1)	2 (2.0)	NS
Adverse maternal outcomes			
Any adverse outcome or death	50 (5.3)	11 (11.2)	< 0.050
Death	0 (0)	0 (0)	-
Uterine artery embolization	0 (0)	0 (0)	-
Hysterectomy	0 (0)	1 (1.0)	0.095
Cystostomy	5 (0.5)	1 (1.0)	NS
Uterine artery ligation	0 (0)	0 (0)	-
Transfusion	31 (3.3)	5 (5.1)	NS
Atony	13 (1.4)	4 (4.1)	0.069
Uterine rupture	1 (0.1)	1 (1.0)	0.180
Wound dehiscence	2 (0.2)	2 (2.0)	< 0.050
Admission to intensive care unit	1 (0.1)	1 (1.0)	0.180
Endometritis	1 (0.1)	0 (0)	NS
Thromboembolic complication	0 (0)	0 (0)	-
Postoperative ileus	3 (0.3)	2 (2.0)	0.073

Data are shown as mean ± standard deviation or number (%).

GAD = gestational age at delivery, CD = cesarean delivery, RDS = respiratory distress syndrome, TTN = transient tachypnea of newborn, CPAP = continuous positive airway pressure, NICU = neonatal intensive care unit, NS = not significant.

Table 3. Relationship of various independent variables with the risk of adverse maternal outcomes analyzed by overall logistic regression analysis

Variables	OR	95% CI	P
GAD	0.895	0.574–1.396	NS
Emergent CD	2.117	1.041–4.303	< 0.050
Maternal age, yr	1.074	1.007–1.145	< 0.050
Indication of CD: previous CD	0.691	0.405–1.179	NS

GAD = gestational age at delivery, CD = cesarean delivery, OR = odds ratio, CI = confidence interval, NS = not significant.

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Table 4. Clinical characteristics and adverse neonatal/maternal outcomes according to the GAD in total study population including both elective and emergency CD

Characteristics	37–37 ⁶ wk (n = 103)	38–38 ⁶ wk (n = 681)	39–39 ⁶ wk (n = 236)	≥ 40 wk (n = 15)	P ^a	P ^b
Maternal characteristics						
Maternal age, yr	33 ± 4	33 ± 4	34 ± 4	32 ± 3	NS	NS
Married ^c	97/98 (99)	641/644 (99.5)	228/228 (100)	14/14 (100)	NS	NS
Nulliparity ^c	27 (26)	188 (28)	82 (35)	8 (53)	< 0.050	< 0.050
Indications for CD^e						
Previous CD	70 (68)	459 (67)	130 (55)	5 (33)	< 0.001	< 0.001
Malpresentation	14 (14)	108 (16)	69 (29)	7 (47)		
Previous uterine surgery	8 (8)	67 (10)	14 (6)	0 (0)		
Others	11 (11)	47 (7)	23 (10)	3 (20)		
Emergency CD ^d	6 (5.8)	56 (8.2)	32 (13.6)	4 (26.7)	< 0.005	< 0.010
GAD, wk	37.6 ± 0.3	38.4 ± 0.3	39.1 ± 0.4	40.2 ± 0.8	< 0.001	
Neonatal characteristics						
Male ^c	52 (51)	334 (49)	119 (50)	6 (40)	NS	NS
Birthweight, g	3,171 ± 363	3,201 ± 352	3,323 ± 438	3,510 ± 426	< 0.001	< 0.001
Small for gestational age ^e	1 (1)	22 (3)	15 (6)	0 (0)	< 0.050	< 0.050
Adverse neonatal outcomes^d						
Any adverse outcome or death	10 (9.7)	34 (5.0)	7 (3.0)	1 (6.7)	< 0.050	< 0.050
Mortality	0 (0)	0 (0)	0 (0)	0 (0)	-	-
RDS or TTN	1 (1.0)	6 (1.0)	0 (0)	0 (0)	NS	NS
Need for respiratory assistant such as CPAP or ventilator	2 (1.9)	3 (0.4)	0 (0)	0 (0)	< 0.050	< 0.050
Proven sepsis	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hypoglycemia (< 35 mg/dL)	0 (0)	3 (0.4)	0 (0)	0 (0)	NS	NS
Admission to the NICU	5 (4.9)	6 (0.9)	4 (1.7)	1 (6.7)	NS	NS
5-min Apgar score ≤ 3	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hospitalization > 10 day	8 (7.8)	18 (2.6)	5 (2.1)	0 (0)	< 0.050	< 0.050
Adverse maternal outcomes^d						
Any adverse outcome or death	4 (4)	42 (6)	14 (6)	1 (7)	NS	NS
Death	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Uterine artery embolization	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Hysterectomy	0 (0)	1 (0.1)	0 (0)	0 (0)	NS	NS
Cystostomy	0 (0)	4 (0.6)	2 (0.8)	0 (0)	NS	NS
Uterine artery ligation	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Transfusion	4 (4)	27 (4)	4 (2)	1 (8)	NS	NS
Atony	0 (0)	11 (2)	6 (3)	0 (0)	NS	NS
Uterine rupture	0 (0)	1 (0.1)	0 (0.4)	0 (0)	NS	NS
Wound dehiscence	0 (0)	4 (1)	0 (0)	0 (0)	NS	NS
Admission in the intensive care unit	0 (0)	2 (0.3)	0 (0)	0 (0)	NS	NS
Endometritis	0 (0)	1 (0.1)	0 (0)	0 (0)	NS	NS
Thromboembolic complication	0 (0)	0 (0)	0 (0)	0 (0)	-	-
Postoperative ileus	0 (0)	3 (0.4)	2 (0.8)	0 (0)	NS	NS

Data are shown as mean ± standard deviation or number (%).

GAD = gestational age at delivery, CD = cesarean delivery, RDS = respiratory distress syndrome, TTN = transient tachypnea of newborn, CPAP = continuous positive airway pressure, NICU = neonatal intensive care unit, NS = not significant.

^aP tested for total; ^bP tested from 37 to 39 weeks only; ^cAnalyzed by χ^2 test; ^dAnalyzed by χ^2 test for trend.

sepsis, iatrogenic fetal injury, uterine rupture, and intrapartum fetal death.^{13,14,16} In the current study, the risk of adverse neonatal outcomes was not increased among emergent CDs.

Until now, few studies have addressed maternal morbidity according to the GAD.¹⁷ In elective CD, maternal morbidity does not appear to be affected by the GAD.¹⁰ In terms of emergency CD, the risk of onset of labor before 39 weeks was 10%–25%,^{3,9} and concerns about an increased risk of maternal mortality and morbidity, such as excessive blood loss, uterine rupture and infections in intrapartum CD, compared to elective CD have also been suggested in emergency operation.^{9,12,18-22} In the current study, the risk of emergent CD increased significantly with increasing planned GAD, and maternal morbidity was greater in cases of

emergent CD. In multiple logistic regression analysis, emergent CD remained a risk factor for adverse maternal morbidity even after adjustment for GAD. However, only the risk of wound dehiscence was increased in emergency CD than in elective CD in the current study, whereas the risk of severe maternal, such as excessive blood loss, uterine rupture and endometritis was not significantly increased. Moreover, when including both cases with elective and emergency operation, the maternal morbidity was not increased according to the planned GAD.

The results of the current study may be used for the counseling women regarding the planning of the gestational age at elective CD. Planning of elective CD at 39 weeks or later is encouraged to decrease the risk of neonatal respiratory morbidity; however it carries the higher risk of emergent CD, which can result in maternal, though not neonatal, morbidity. In addition, emergent CD carries the risk of lower medical service qualities in terms of operating facilities and health professionals, especially in resource-constrained countries.²³ However, as a total (when including both cases with elective and emergency operation), the maternal morbidity was not increased according to the planned GAD. And the neonatal morbidity was decreased according to planned gestational age, as a total.

The limitation of the current study is the nature of the current study which is retrospective study; further prospective randomized trials may be needed to compare the risk and benefit according to the timing of elective CD.

Further studies may be needed to evaluate the risk of other adverse outcomes and the planned gestational age for CD. In the current study, we excluded cases of fetal death in utero, cases with maternal disease such as hypertensive disease in pregnancy or clinical chorioamnionitis prior to delivery, and cases with a non-reassuring fetal status or placental abruption; all of these may develop while awaiting elective delivery at 39 weeks or later.^{24,25} Therefore, the risk versus benefit of postponing elective CD until 39 weeks of gestation also needs to be evaluated with regards to these complications.

No prospective randomized trials have been conducted to compare the risk and benefit between the timing of elective CD before and after 39 weeks of gestation.¹² From the results of the current study and previous retrospective studies, we may postulate that neonatal respiratory morbidities may be lower but maternal morbidities may be similar in the strategies of timing of elective CD after 39 weeks of gestation. Additionally, other neonatal morbidities such as perinatal mortality should be evaluated. The determination of optimal delivery timing for elective CD is very important issue, considering that the CD rate is about 20%–40% in various countries and 35% in Korea.²⁶

In conclusion, the risk of emergent CD increased with increasing planned gestational age for elective CD, and the risk of adverse maternal outcomes was higher with emergent CD. However, the risk of adverse maternal outcomes did not increase according to the planned gestational age in the total study population including both cases with elective and emergency CD.

REFERENCES

1. Ghartey K, Coletta J, Lizarraga L, Murphy E, Ananth CV, Gyamfi-Bannerman C. Neonatal respiratory morbidity in the early term delivery. *Am J Obstet Gynecol* 2012;207(4):292.e1-4.

[PUBMED](#) | [CROSSREF](#)

2. Tita AT, Landon MB, Spong CY, Lai Y, Leveno KJ, Varner MW, et al. Timing of elective repeat cesarean delivery at term and neonatal outcomes. *N Engl J Med* 2009;360(2):111-20.
[PUBMED](#) | [CROSSREF](#)
3. Morrison JJ, Rennie JM, Milton PJ. Neonatal respiratory morbidity and mode of delivery at term: influence of timing of elective caesarean section. *Br J Obstet Gynaecol* 1995;102(2):101-6.
[PUBMED](#) | [CROSSREF](#)
4. Zanardo V, Simbi AK, Franzoi M, Soldà G, Salvadori A, Trevisanuto D. Neonatal respiratory morbidity risk and mode of delivery at term: influence of timing of elective caesarean delivery. *Acta Paediatr* 2004;93(5):643-7.
[PUBMED](#) | [CROSSREF](#)
5. Bates E, Rouse DJ, Mann ML, Chapman V, Carlo WA, Tita AT. Neonatal outcomes after demonstrated fetal lung maturity before 39 weeks of gestation. *Obstet Gynecol* 2010;116(6):1288-95.
[PUBMED](#) | [CROSSREF](#)
6. American College of Obstetricians and Gynecologists. ACOG committee opinion no. 561: nonmedically indicated early-term deliveries. *Obstet Gynecol* 2013;121(4):911-5.
[PUBMED](#) | [CROSSREF](#)
7. Hansen AK, Wisborg K, Uldbjerg N, Henriksen TB. Elective caesarean section and respiratory morbidity in the term and near-term neonate. *Acta Obstet Gynecol Scand* 2007;86(4):389-94.
[PUBMED](#) | [CROSSREF](#)
8. van den Berg A, van Elburg RM, van Geijn HP, Fetter WP. Neonatal respiratory morbidity following elective caesarean section in term infants. A 5-year retrospective study and a review of the literature. *Eur J Obstet Gynecol Reprod Biol* 2001;98(1):9-13.
[PUBMED](#) | [CROSSREF](#)
9. Hansen AK, Wisborg K, Uldbjerg N, Henriksen TB. Risk of respiratory morbidity in term infants delivered by elective caesarean section: cohort study. *BMJ* 2008;336(7635):85-7.
[PUBMED](#) | [CROSSREF](#)
10. Tita AT, Lai Y, Landon MB, Spong CY, Leveno KJ, Varner MW, et al. Timing of elective repeat cesarean delivery at term and maternal perioperative outcomes. *Obstet Gynecol* 2011;117(2 Pt 1):280-6.
[PUBMED](#) | [CROSSREF](#)
11. Yee W, Amin H, Wood S. Elective cesarean delivery, neonatal intensive care unit admission, and neonatal respiratory distress. *Obstet Gynecol* 2008;111(4):823-8.
[PUBMED](#) | [CROSSREF](#)
12. Salim R, Shalev E. Health implications resulting from the timing of elective cesarean delivery. *Reprod Biol Endocrinol* 2010;8(1):68.
[PUBMED](#) | [CROSSREF](#)
13. Richardson BS, Czikk MJ, daSilva O, Natale R. The impact of labor at term on measures of neonatal outcome. *Am J Obstet Gynecol* 2005;192(1):219-26.
[PUBMED](#) | [CROSSREF](#)
14. Hook B, Kiwi R, Amini SB, Fanaroff A, Hack M. Neonatal morbidity after elective repeat cesarean section and trial of labor. *Pediatrics* 1997;100(3 Pt 1):348-53.
[PUBMED](#) | [CROSSREF](#)
15. Baskett TF, Allen VM, O'Connell CM, Allen AC. Predictors of respiratory depression at birth in the term infant. *BJOG* 2006;113(7):769-74.
[PUBMED](#) | [CROSSREF](#)
16. Aburezq H, Chakrabarty KH, Zuker RM. Iatrogenic fetal injury. *Obstet Gynecol* 2005;106(5 Pt 2):1172-4.
[PUBMED](#) | [CROSSREF](#)
17. Wetta L, Tita AT. Early term births: considerations in management. *Obstet Gynecol Clin North Am* 2012;39(1):89-97.
[PUBMED](#) | [CROSSREF](#)
18. Lilford RJ, van Coeverden de Groot HA, Moore PJ, Bingham P. The relative risks of caesarean section (intrapartum and elective) and vaginal delivery: a detailed analysis to exclude the effects of medical disorders and other acute pre-existing physiological disturbances. *Br J Obstet Gynaecol* 1990;97(10):883-92.
[PUBMED](#) | [CROSSREF](#)
19. Kolås T, Øian P, Skjeldestad FE. Risks for peroperative excessive blood loss in cesarean delivery. *Acta Obstet Gynecol Scand* 2010;89(5):658-63.
[PUBMED](#) | [CROSSREF](#)
20. Magann EF, Evans S, Hutchinson M, Collins R, Lanneau G, Morrison JC. Postpartum hemorrhage after cesarean delivery: an analysis of risk factors. *South Med J* 2005;98(7):681-5.
[PUBMED](#) | [CROSSREF](#)

21. Chua SC, Joung SJ, Aziz R. Incidence and risk factors predicting blood transfusion in caesarean section. *Aust N Z J Obstet Gynaecol* 2009;49(5):490-3.
[PUBMED](#) | [CROSSREF](#)
22. Zia S, Rafique M. Intra-operative complications increase with successive number of caesarean sections: myth or fact? *Obstet Gynecol Sci* 2014;57(3):187-92.
[PUBMED](#) | [CROSSREF](#)
23. Govender V, Panday M, Moodley J. Second stage caesarean section at a tertiary hospital in South Africa. *J Matern Fetal Neonatal Med* 2010;23(10):1151-5.
[PUBMED](#) | [CROSSREF](#)
24. Smith GC, Pell JP, Dobbie R. Caesarean section and risk of unexplained stillbirth in subsequent pregnancy. *Lancet* 2003;362(9398):1779-84.
[PUBMED](#) | [CROSSREF](#)
25. Wood SL, Chen S, Ross S, Sauve R. The risk of unexplained antepartum stillbirth in second pregnancies following caesarean section in the first pregnancy. *BJOG* 2008;115(6):726-31.
[PUBMED](#) | [CROSSREF](#)
26. Chung SH, Seol HJ, Choi YS, Oh SY, Kim A, Bae CW. Changes in the caesarean section rate in Korea (1982–2012) and a review of the associated factors. *J Korean Med Sci* 2014;29(10):1341-52.
[PUBMED](#) | [CROSSREF](#)