

# Clinical evaluation of anesthesia for high-risk cesarean section at a tertiary medical center: retrospective study for 8 years (2009–2016)

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## Abstract

**Objective:** The number of high-risk pregnancies is increasing in tertiary medical centers. Therefore, we investigated perioperative outcomes based on risk factors to ascertain proper maternal and neonatal management.

**Methods:** We reviewed the medical records of patients receiving cesarean sections over an 8-year period. Clinical parameters for anesthesia and the neonatal outcome were compared among high-risk groups after subdivision by the number of clinical risk factors. The groups were as follows: group A (one risk factor), group B (two risk factors), and group C (three or more risk factors).

**Results:** Patient age, estimated blood loss (EBL), and volume of transfused red blood cell (RBC) were higher in group B than group A. Birth weight, 1- and 5-minute Apgar scores, and gestational age were lower while the frequency of neonatal intensive care unit (NICU) admission was higher in group B than group A. Group C patients were significantly older than group A or B patients. Birth weight, 1- and 5-minute Apgar scores and gestational age were significantly lower while frequency of NICU admission was higher in group C than group A and B.

**Conclusion:** The number of maternal risk factors was positively associated with adverse outcomes in the neonates.

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**Keywords**

Apgar score, birth weight, cesarean section, estimated blood loss, gestational age, high-risk delivery, obstetric anesthesia

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**Introduction**

Cesarean section is an essential obstetric surgery that is performed when vaginal delivery is difficult or threatens the safety of the mother or fetus.<sup>1</sup> Obstetric anesthesiologists have to know the anatomical and physiological changes that occur in pregnancy and delivery, prepare for the risk of hemodynamic instability resulting from massive hemorrhage, and treat newborns immediately after delivery. Previously, we retrospectively compared the clinical outcomes over 5 years of high-risk and non-high-risk patients receiving cesarean section.<sup>2</sup> Here, we further investigate high-risk patients. The term “high-risk pregnancy” includes all situations where the risks for both the mother and fetus are increased during pregnancy or delivery. However, qualifying criteria for high-risk pregnancy vary between studies.<sup>3–5</sup> Malinow and Ostheimer<sup>3</sup> defined high-risk mothers as those with preeclampsia/eclampsia, diabetes, premature labor, multiple pregnancy, infectious disease, or existing neurological or cardiac disorders. Krilova’s<sup>4</sup> definition included existing or pregnancy-related medical conditions that posed a likely risk to the fetus, preeclampsia, diabetes, placenta previa, multiple pregnancy, intrauterine growth retardation, oligohydramnios, and breech presentation. In this study, we used the term “high-risk delivery” as a concept, including the risks to the mother, fetus, and during delivery, with the definition based on the following six risk factors: 1) any form of hypertension

during pregnancy (chronic hypertension, gestational hypertension, preeclampsia, superimposed preeclampsia, or eclampsia); 2) peripartum hemorrhage (placental abruption or placental abnormality); 3) multiple gestations; 4) underlying maternal disease (cardiovascular, renal, hematological, respiratory, neural, or infectious diseases); 5) cases in which emergency cesarean section was necessary (fetal distress, prolapse of the umbilical cord, or uterine rupture); and 6) advanced maternal age (35 years or older). We previously reported that high-risk pregnancy had unfavorable clinical outcomes for both the mothers and newborns compared with non-high-risk pregnancy.<sup>2</sup> We now report the differences within the high-risk group. The reported percentage of high-risk pregnancies ranges from 6% to 30% because the situations and conditions that constitute high-risk pregnancy are varied.<sup>6,7</sup> Smulian et al.<sup>8</sup> claimed that high-risk conditions are associated an increased risk of fetal death. In some countries or hospitals, anesthesiologists also manage cesarean section for newborn and maternal care. There may also be differences in opinion about the high risk of mothers between an anesthesiologist and an obstetrician. This can have a significant impact on maternal and fetal outcomes, especially in high-risk pregnancies. The aim of this study was to compare perioperative neonatal and maternal outcomes based on the number of risk factors in high-risk mothers who underwent

cesarean section to better guide anesthetic management of cesarean deliveries.

## Patients and methods

### Patients

We retrospectively investigated the clinical characteristics of patients who underwent cesarean delivery in the Department of Obstetrics and Gynecology during the 8-year period between 2009 and 2016. The study was approved by the hospital's institutional review board (2018AS0090, 2018.5.2). The patients in the high-risk group were divided into six groups as described in our previous paper.<sup>2</sup> In this paper, high-risk cesarean delivery groups with one, two, and three or more risk factors were classified into groups A, B, and C, respectively. Then, we reviewed the patients' medical records and recorded the following characteristics: patient's age, duration of anesthesia, duration of operation, estimated blood loss (EBL), the amount of intraoperative infusion solution administered, frequency of intraoperative red blood cell (RBC) transfusions, volume of transfused RBCs, and additional administration of uterotonics. We also observed the changes in the proportion of high-risk mothers over the 8-year period.

These data in groups A, B, and C were then compared with the neonatal characteristics of birth weight, 1- and 5-minute Apgar scores, gestational age, frequency of NICU admissions, and stillbirth rates among groups A, B, and C.

### Ethics and consent

The Korea University Ansan Hospital Institutional Review Board granted ethics permission (2018AS0090, 2018.5.2), and indicated that signed informed consent

was not required because this research involved a review of medical records.

### Statistical analysis

Statistical analyses were performed using SPSS software (version 20.0, SPSS Inc., IBM Corp., Armonk, NY, USA). All values were presented as mean  $\pm$  standard deviation (SD) or frequency. The Apgar score was expressed as the median (interquartile range, IQR). The Kruskal–Wallis test was used to compare patient's age, anesthetic time, surgical time, EBL, volume of transfused RBCs, birth weight, 1- and 5-minute Apgar scores, and gestational age for the three groups and if there was a significant difference between the three groups, we used the pairwise test using the Mann–Whitney *U* test with the Bonferroni correction. The chi-squared test was used to compare the frequency of blood transfusion, frequency of additional use of uterotonics, frequency of NICU admissions, and rates of stillbirth between the three groups. The chi-squared test was additionally used to assess the trend in the proportion of high-risk mothers over the 8-year period. A *p*-value less than 0.05 was considered to be significant.

## Results

There were 3291 deliveries at our hospital between January 2009 and December 2016. Among them, 1866 (56.7%) were cesarean section deliveries. The average maternal age, weight, and height was  $33.1 \pm 4.7$  years,  $79.3 \pm 15.2$  kg, and  $160.3 \pm 5.8$  cm, respectively, and the BMI was  $28.08 \pm 4.84$  kg/m<sup>2</sup>. Additionally, 705 deliveries (37.8%) were to women of advanced maternal age (35 years or older).

Overall, 91.3% of the cesarean deliveries were performed under general anesthesia, 5.9% by spinal anesthesia, 2.4% by

combined spinal–epidural anesthesia, and 0.3% by epidural anesthesia. The non-high-risk and high-risk cesarean delivery groups comprised 492 (26.4%) and 1374 (73.6%) pregnant women, respectively.

The high-risk cesarean delivery group was subdivided based on the number of risk factors, with 781 patients (41.9%) with one risk factor in group A, 459 patients (24.6%) with two risk factors in group B, and 134 patients (7.2%) with three or more risk factors in group C. The patients' age was significantly different between the three groups. In group C, the average maternal age was the highest followed by group B, and then group A ( $p < 0.001$  for all). EBL and the volume of transfused RBC were significantly higher in group B compared with group A ( $p < 0.001$  for both). There were significant differences between each group in the frequency of RBC transfusion and the frequency of additional use of uterotonics; group B had the highest frequency, followed by group C then group A ( $p < 0.05$  for both; Table 1). In group A, the

proportion of women with a peripartum hemorrhage was 18.8% (147/781), in group B, it was 41.0% (188/459), and in group C, it was 44% (59/134).

Birth weight, 1- and 5-minute Apgar scores, and gestational age were all lower while the frequency of admission to the NICU was higher in group B compared with group A ( $p < 0.001$  for all). Birth weight, 1-minute Apgar scores, and gestational age were lower, while the frequency of admission to the NICU was higher in Group C compared with groups A and B ( $p < 0.001$  for all). There were significant differences between each group in the rate of stillbirth, with group C having the most stillbirths followed by group A and then group B ( $p < 0.05$ ; Table 2).

Fetal distress was noted in 233 patients who underwent cesarean delivery. When stratified by risk factor, fetal distress was present in 88 of the 781 patients with one risk factor (11.3%), 94 of the 459 patients with two risk factors (20.5%), and 51 of the 134 patients with three or more risk factors (38.1%). The proportion of cesarean

**Table 1.** Clinical outcomes among high-risk groups.

	Group A (N = 781)	Group B (N = 459)	Group C (N = 134)	P-value
Age (year)	32.4 ± 4.5	34.3 ± 4.7*	35.7 ± 4.3 <sup>†</sup>	<0.05
Anesthetic time (min)	70.9 ± 17.9	72.0 ± 18.8	76.3 ± 26.1	NS
Surgical time (min)	50.3 ± 16.9	51.1 ± 16.9	54.2 ± 20.2	NS
EBL (mL)	468.3 ± 247.6	548.3 ± 359.5*	528.4 ± 380.3	<0.001
Total fluid (mL)	944.8 ± 657.4	1039.1 ± 664.9	988.2 ± 856.6	NS
Transfusion	65 (8.3%)	75 (16.3%)	16 (11.9%)	<0.001**
Packed RBC (mL)	32.1 ± 162.0	63.62 ± 189.4*	63.81 ± 217.7	<0.001
Additional drugs for uterine contraction	411 (52.6%)	295 (64.3%)	80 (59.7%)	<0.001**

Group A, parturient with one high risk factor.

Group B, parturient with two high risk factors.

Group C, parturient with three or more high risk factors.

Values are presented as the mean ± SD or the number of patients (%).

EBL, estimated blood loss; RBC, red blood cell, NS, not significant

\* $P < 0.001$  compared with the Group A (A-B).

<sup>†</sup> $P < 0.05$  compared with the Group C (B-C).

\*\*Chi-squared test ( $P < 0.05$ ).

**Table 2.** Clinical outcomes of neonates in the high-risk groups.

	Group A (N = 847)	Group B (N = 529)	Group C (N = 167)	P-value
Birth Weight (g)	2653.7 ± 812.3	2505.8 ± 832.8*	2077.8 ± 768.0 <sup>†</sup>	<0.001
Apgar score 1 min	8 (7–9)	8 (6–9)*	7 (5–8.5) <sup>†</sup>	<0.001
Apgar Score 5 min	9.5 (9–10)	9.0 (8–10)*	9.0 (8–10) <sup>‡</sup>	<0.05
Gestational age (day)	252.9 ± 24.2	249.9 ± 23.5*	241.1 ± 23.0 <sup>†</sup>	<0.001
NICU admission	349 (44.7%)	252 (54.9%)*	101 (75.4%) <sup>†</sup>	<0.001
Stillbirth	9 (1.2%)	2 (0.4%)	4 (3.0%)	0.048**

Group A, neonate born to parturient with one high risk factor.

Group B, neonate born to parturient with two high risk factors.

Group C, neonate born to parturient with three or more high risk factors.

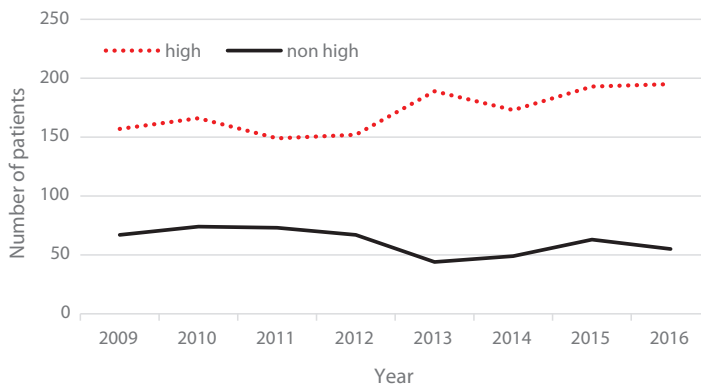
Values are presented as the mean ± SD or number of patients (%). Apgar scores are presented as the median (IQR). NICU, neonatal intensive care unit, NS, not significant.

\*Kruskal–Wallis test,  $P < 0.001$  compared with the Group A (B-A).

<sup>†</sup>Kruskal–Wallis test,  $P < 0.001$  compared with the Groups A or B (C-B, C-A).

<sup>‡</sup>Kruskal–Wallis test,  $P < 0.05$  compared with the Groups A or B (C-B, C-A).

\*\*Chi-squared test,  $P < 0.05$ .

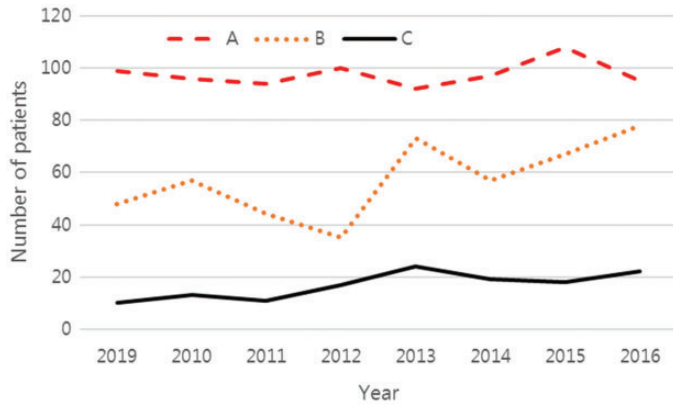


**Figure 1.** A comparison of trends in annual high-risk and non-high risk groups. The chi-squared test showed that the p-value was 0.0005, which means that the proportion of high-risk groups per year increased significantly.

deliveries that were high-risk compared with non-high-risk showed a statistically significant increase by year ( $p < 0.05$ ; Figure 1). When stratified by group, there was a significant decreasing trend in the number of patients in group A ( $P < 0.05$ ), a significant increasing trend in the number of patients in group B ( $P < 0.05$ ), and no change in the number of patients in group C over time (Figure 2).

## Discussion

Between January 2009 and December 2016, 1866 of 3291 (56.7%) deliveries that were performed at our hospital were cesarean sections. This rate is higher than the average cesarean section rate of 52.7% that occurred in tertiary medical centers between 2012 and 2016, according to the Korean National Statistical Office. The pregnancies



**Figure 2.** A comparison of annual trends for each group. The chi-squared test showed a statistically significant decrease in caesarian sections group A ( $P < 0.05$ ), an increase in group B ( $P < 0.05$ ), and no change in group C.

Group A, neonate born to a parturient with one high-risk factor.

Group B, neonate born to a parturient with two high-risk factors.

Group C, neonate born to a parturient with three and more high-risk factors.

were high-risk in 1374 of the cesarean deliveries (73.6%) over the 8-year period, with an average frequency of 171 cesarean sections performed per year. The number of emergency cesarean sections was 1195 (64.04%). This rate is very high compared with that of other hospitals in South Korea as well as hospitals in other nations.<sup>9,10</sup> The reason for the high rate of cesarean delivery is likely because our hospital is the only tertiary medical center with sufficient facilities, equipment, and human resources to care for high-risk deliveries in an urban area with 1 million people. The rate of high-risk cesarean delivery is increasing every year in tertiary medical centers.<sup>9</sup> In this study, the proportion of high-risk cesarean deliveries by year showed a statistically significant increase compared with non-high-risk cesarean delivery (Figure 1). The group with one risk factor showed a decreasing trend for caesarian sections each year and the group with two risk factors showed that cesarean sections increased yearly, while the group with three or more risk factor had no change (Figure 2). This may be because

pregnant women with one risk factor likely did not go to the tertiary hospital for their cesarean section. The reason for the increase in the number of women with two risk factors is thought to be because of the increase in the proportion of mothers at an advanced age who undergo delivery via cesarean section. Cesarean sections accounted for a high proportion of total deliveries because there are many cases in which emergency delivery becomes a necessity as a result of a medical condition in the mother or fetus or when complications develop. Planned, scheduled cesarean deliveries are increasing in number, and the reasons for this include increased prevalence of previous cesarean section, more mothers of advanced maternal age, social and cultural change, and medicolegal considerations.<sup>11,12</sup> Recently, advanced maternal age was recognized as an important factor that increases the rate of cesarean delivery.<sup>11,12</sup> In this study, 705 deliveries (37.8%) were to women of advanced maternal age (35 years or older). Additionally, maternal age was significantly higher in

group C, which included women with three or more risk factors. Furthermore, 91.3% of patients who received a cesarean section had general anesthesia.

Our hospital has a high rate of high-risk deliveries and emergency cesarean sections. In urgent situations where there was not enough time to administer regional anesthesia, both obstetricians and anesthesiologists preferred general anesthesia. Difficulty with endotracheal intubation is a risk of anesthesia and it can be complicated by obesity in pregnant patients.<sup>13</sup> Soens et al.<sup>14</sup> reported that the incidence of airway difficulties among obese patients is higher than the general population. Thus, obstetric anesthesiologists prefer regional anesthesia for cesarean section. Palanisamy et al.<sup>15</sup> reported that in least 50% of all cesarean deliveries in which general anesthesia was used, the decision to use general anesthesia was based on insufficient time to administer neuraxial anesthesia, and emergency cesarean sections accounted for 85% of cases in which general anesthesia was used. Hawkins et al.<sup>16</sup> found that anesthesia-related deaths during cesarean sections under general anesthesia were lower between 1991 and 2002 compared with between 1979 and 1990. A recent meta-analysis reported that neuraxial anesthesia did not yield better maternal or neonatal outcomes than general anesthesia.<sup>17</sup> In our study, because the mean weight of our patients was  $79.3 \pm 15.2$  kg and the BMI was  $28.08 \pm 4.84$  kg/m<sup>2</sup>, there were no difficult intubation cases. Generally, Koreans have lower obesity levels than Westerners, so airway management is not difficult. This lower obesity level and lower BMI in Korean people is a great advantage when providing general anesthesia to parturients. Overall, general anesthesia is the preferred management for high-risk patients who are undergoing a cesarean section at our hospital to reduce maternal emotional stress

regarding neonatal health and to enable more rapid and easier management of maternal hemodynamic instability. However, the risks involved in cesarean delivery are known to increase under general anesthesia.<sup>18</sup>

The high rate of high-risk pregnancies, emergency cesarean sections, and common general anesthesia created a special circumstance at our hospital that enabled examination of the effect of the number of risk factors on maternal and fetal outcomes after high-risk cesarean delivery. EBL and the volume of transfused RBCs were significantly different in group B compared with group A. This may be because many patients were classified as having peripartum hemorrhage among their risk factors. In group A, the proportion of women with a peripartum hemorrhage was 147/781 (18.8%), while in group B 188/459 (41.0%). In group C, there was no statistical significance compared with groups A and B, and EBL and transfused packed RBCs were significantly different in group B compared with group A, but there was no statistical significance in group C. In group C, the proportion of women with peripartum hemorrhage was 59/134 (44%). Thus, the frequency of additional use of uterotonics was also the highest in group B. Therefore, preoperative communication with the obstetrician before surgery is crucial to clarify the patient's risks. For high-risk cesarean delivery cases with risk of peripartum hemorrhage, we recommend having a large bore intravenous line, blood, and potentially necessary drugs on hand, and the surgery should take place under the care of an experienced obstetric anesthesiologist. In group C, neonatal birth weight, 1- and 5-minute Apgar scores, and gestational age were significantly lower, and the frequency of NICU admission was higher compared with groups A and B. Stillbirth was also highest in group C compared with groups A and B. Other neonatal

outcomes were the worst in group C. The more risk factors that the mother has, the more likely it is to affect the wellbeing of the fetus, which suggests that there may not be a good neonatal outcome. This may explain the differences in fetal outcome among the three groups. Effective treatment is immediately required in cases of severely depressed newborns to avoid neurological damage. Sufficient knowledge about managing newborns and cardiopulmonary resuscitation is crucial.<sup>19</sup>

We found that there were no significant differences in the duration of anesthesia or surgery between high-risk delivery groups, although there was no significant trend towards longer surgical times in the group with more risk factors. This is because the obstetricians at our hospital have significant expertise and experience with high-risk deliveries. The skill of the attending obstetrician affects the outcomes of anesthesia and the neonate. If the obstetrician lacks sufficient experience, these outcomes can become more serious. Thus, an obstetric anesthesiologist should consider the obstetrician's ability as well as the risk associated with anesthesia for the mother and fetus.

The limitations of this study are that the impacts of the individual risk factors were not evaluated. The impact of each individual risk factor on maternal and neonatal outcomes could be different, and better maternal/fetal outcomes are possible if the risk factors are individually assessed. The number of maternal risk factors was positively associated with adverse outcomes of the neonates, which may be difficult to generalize. This study analyzed 1374 high-risk pregnant women who underwent cesarean section (an average of 171 per year) and highlighted the capacity of the medical staff and systems at our hospital. The results may not be generalizable to other hospitals, which is a limitation of the study. Obstetric anesthesiologists need to

be knowledgeable about high-risk deliveries and proper maternal and neonatal management, especially if patients have two or more high-risk factors. Additionally, the obstetric anesthesiologist should cooperate closely with the obstetrician during anesthesia in high-risk pregnant women and consult with the pediatrician for immediate and appropriate treatment if the neonate's wellbeing is in danger.


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The authors declare that there is no conflict of interest.

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