

## Clinical evaluation of anesthesia for cesarean section at tertiary medical center: retrospective study for 5 years (2009–2013)

Department of Anesthesiology and Pain Medicine, Korea University Ansan Hospital, Korea University College of Medicine, Ansan, Korea

Sang Hee Park, Dong Jun Kim, Woon Young Kim, Jae Hwan Kim, Yoon-Sook Lee, and Young Cheol Park

**Background:** Cesarean section anesthesia requires adequate preparation because of maternal physiologic changes, a higher risk for massive maternal bleeding, neonatal considerations, and a higher frequency of emergency operations. Therefore, we retrospectively compared clinical outcomes of cesarean section patients between a high-risk group and non-high-risk group in order to improve anesthesia care.

**Methods:** We reviewed medical records from cesarean section cases at our tertiary medical center for 5 years (2009–2013). Parameters included the anesthesia and operative time; estimated blood loss, fluid volume and blood products administered during surgery, additional administration of maternal uterotonic medications; as well as the birth weight, Apgar scores, number of neonatal intensive care unit (NICU) admissions, and stillbirth rates of the neonate.

**Results:** The total number of delivery cases was 1935 during the 5 years, and the cesarean section cases accounted for 58.8% (1,138 cases). There were 735 emergency surgery cases (64.6%), and 813 (71.4%) patients were in the high-risk group. Estimated blood loss, fluid volume used, and the frequency and amount of blood transfusions were statistically higher in the high-risk group. Among 1,243 neonates, 918 (73.9%) were born from high-risk mothers. Neonatal birth weights and Apgar scores (1 and 5 minutes) from patients in the high-risk group were statistically lower than those in the non-high-risk group, and NICU admissions and stillbirths were statistically higher in the high-risk group.

**Conclusions:** Anesthesiologists should be aware of unfavorable clinical outcomes in high-risk cesarean section groups and carefully prepare for anesthesia care in these cases. (*Anesth Pain Med* 2016; 11: 49–54)

**Key Words:** Cesarean section, High-risk delivery, Obstetric anesthesia.

### INTRODUCTION

A cesarean section is a surgery that incises the mother's abdomen and uterus, and subsequently delivers the fetus. This surgery is one of the basic procedures in obstetrics, and is used when vaginal delivery is judged impossible such as when the safety or lives of the mother or fetus are threatened [1]. Anesthetic management of cesarean sections requires more preparation and a thorough understanding of patients as compared to general anesthetic management because of maternal basic anatomical and physiological changes, risks from massive maternal hemorrhage or hemodynamic instability, risks for neonates immediately after the delivery, and the high frequency of emergency surgery.

The ratio of cesarean sections compared to all deliveries has steadily increased throughout the world. This increase is caused by the development of fetal monitoring, the development of intensive treatment technologies for premature babies, the increase of repeat cesarean sections after a previous one, the increase of elderly primiparas, obstetricians' avoidance of vaginal delivery due to changes in social perspective in medical institutions, medical personnel and medical practices, the legal system, and the expansion of surgical indications for the procedure [1,2]. The frequency of cesarean sections in South Korea steadily increased to 43% of the total number of deliveries in 1999 [3]. However, since the year 2000, the rate has decreased slightly. The ratio ranged from 36.0–36.4% from 2006 to 2011. This ratio is much higher than the 5–15% rate recommended by the World Health Organization (WHO), and the 25.8%, average of the Organisation for Economic Cooperation and Development (OECD) countries in 2009 [4].

Received: August 25, 2015.

Revised: 1st, October 8, 2015; 2nd, October 12, 2015; 3rd, October 19, 2015.

Accepted: October 20, 2015.

Corresponding author: Woon Young Kim, M.D., Ph.D., Department of Anesthesiology and Pain Medicine, Korea University Ansan Hospital, 123, Jeokgeum-ro, Danwon-gu, Ansan 15355, Korea. Tel: 82-31-412- 5297, Fax: 82-31-412-5294, E-mail: ckssis@korea.ac.kr

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

In our hospital, the number of cesarean sections per year is over 200, and the ratio of cesarean sections to all deliveries is about 60%, which is higher than the average for South Korea. The rate is higher because our hospital is the only tertiary medical center in the city area, and high-risk delivery patients are concentrated in our hospital rather than distributed to other hospitals. It is necessary for anesthesiologists to perform fast and appropriate anesthetic management for these high-risk patients. Therefore, we investigated clinical characteristics of our hospital's cesarean section patients through a retrospective survey of cesarean section anesthetic management. This study was carried out in the department of obstetrics and gynecology of our hospital for 5 years, from 2009 through 2013. Characteristic cesarean section clinical outcomes of high-risk delivery patients were compared with those of non-high-risk patients to determine appropriate cesarean section anesthetic management in the future.

## MATERIALS AND METHODS

This study investigated the ratio of cesarean sections to all deliveries at our hospital's department of obstetrics and gynecology from January 2009 through December 2013. Medical records of cesarean section parturients were reviewed annually. We collected the following patient demographic data at the time of the cesarean section: the patients' age, gestational age, height and weight means, and body mass index (BMI). We also examined underlying medical conditions of surgical patients, whether antenatal care was conducted, frequency of prior elective and emergency surgery, and previous methods of anesthesia. In addition, the review surveyed the major indications for performing the cesarean section.

The term high-risk delivery was used in this study and included risks in the mother, the fetus, and the delivery itself. High-risk delivery risk factors were divided into six categories: 1)

hypertension during pregnancy (gestational hypertension, preeclampsia, eclampsia, superimposed preeclampsia, chronic hypertension), 2) peripartum hemorrhage (placental abnormality, placenta abruptio), 3) multiple gestations, 4) mother's underlying disease (cardiovascular, respiratory, renal, neural, hematological and infectious diseases), 5) cases in which an emergency cesarean section was necessary (prolapse of the umbilical cord, fetal distress, and uterine rupture), and 6) elderly primipara (age 35 years or older). Any case that fell under at least one of these categories was defined as a high-risk delivery. The patients were divided into mothers with risk factors of high risk delivery and those without. Differences in time under anesthesia, operative time, estimated blood loss, the amount of infusion solution administered during surgery, the frequency of blood transfusions during surgery, the amount of red blood cell concentrates transfusion, and additional administration of uterotonic medications were compared. Moreover, the birth weights of neonates, the 1 and 5 minutes Apgar scores, the ratio of neonatal intensive care unit (NICU) admissions, and the stillbirth rates from the non-high-risk delivery group and the high-risk delivery group were investigated.

The basic values reported include the mean  $\pm$  the standard deviation or the frequency. SPSS version 20.0 was used for statistical analysis. First, each of the values was analyzed to determine whether they followed a normal distribution. Since all of the values did not follow a normal distribution, a Mann-Whitney U test was applied for mean separation, and the  $\chi^2$  test was applied for frequency testing. A P value below 0.05 was considered statistically significant.

## RESULTS

The total number of deliveries carried out in our hospital from January 2009 through December 2013 was 1,935 cases; and the number of cesarean sections among them was 1,138 cases or 58.8% of all cases (Table 1). The average maternal age was  $32.7 \pm 4.8$  years; the average weight,  $71.4 \pm 13.3$  kg; the average height,  $159.6 \pm 5.8$  cm; and the average BMI,  $28.0 \pm 4.7$  kg/m<sup>2</sup>. The number of patients by age group was 8 persons under the age of 19 years, 39 persons between the ages of 20 and 24 years, 228 persons between the ages of 25 and 29 years, 477 persons between the ages of 30 and 34, 293 persons between the ages of 35 and 39 years, and 93 persons over the age of 40 years. The mean gestational age of patients who underwent a cesarean section was  $254 \pm 22.8$  days. The number of mothers who did not receive any

**Table 1.** Relative Frequencies of Cesarean Section by Year

Year	Total C-sec/ Total delivery (%)	High-risk C-sec delivery/ Total C-sec (%)
2009	224/373 (60.0)	158/224 (70.5)
2010	240/348 (69.0)	166/240 (69.2)
2011	222/413 (53.8)	149/222 (67.1)
2012	219/415 (52.8)	152/219 (69.4)
2013	233/386 (60.4)	188/233 (80.7)
Total	1,138/1,935 (58.8)	813/1,138 (71.4)

antenatal care until the delivery was 26 persons. The total number of mothers who had an underlying disease was 382 persons (Table 2).

The number of cesarean sections included 403 cases of elective surgery (35.4%) and 735 cases of emergency surgery (64.6%); emergency surgery comprised about two-thirds of the total number of cases. The most common anesthesia method used was general anesthesia (1,037 persons, 91.2%), followed by spinal anesthesia (52 persons, 4.6%), epidural anesthesia (5 persons, 0.4%), and combined spinal-epidural anesthesia (43 persons, 3.8%). The average anesthesia time was  $68.5 \pm 19.7$  min, and the average operative time was  $47.0 \pm 17.6$  min. Indications for cesarean section included a previous cesarean section history, abnormal presentation of the fetus, fetal distress, eclampsia/preeclampsia, placenta previa, failure to progress, multiple gestation, elderly primipara, placenta abruptio, placenta accrete/increta, and fetal anomaly. There were 709 cases with more than two indications, which included 62.3% of the total number of patients (Table 3).

As stated above, the patients were divided into a high-risk delivery group and a non-high-risk delivery group. The non-high-risk delivery group was composed of 325 persons (28.6%) while the high-risk delivery group was composed of 813 persons (71.4%). The number of patients within each high-risk group category was as follows: 1) 232 persons with hypertension during pregnancy, 2) 283 persons with peripartum hemorrhage, 3) 104 persons with multiple gestations, 4) 383 persons with maternal underlying disease, 5) 214 persons who required an emergency cesarean section, and 6) 21 persons who were elderly primiparas. Patients in the high-risk delivery

group had significantly more estimated blood loss, more infusion solution administered during surgery, a higher frequency of blood transfusion during surgery, and higher amounts of red blood cell concentrates transfusion as compared to the non-high-risk delivery group. In addition, the uterotonic oxytocin 20 units was administered to all mothers immediately after the delivery; and there was a significant difference in the frequency of additional administration of uterotonics such as carbetocin (duratocin), methylergometrine maleate (erugin), and sulprostone (nalador) (Table 4).

Of the 1,138 total cases of cesarean sections, there were 104 cases of multiple gestations, and the total number of neonates included 1,243 persons. In that group, neonates from the high-risk delivery group had significantly lower birth weights, and lower 1 and 5 minutes Apgar scores. The number of neonates admitted to the NICU simultaneously with their birth-mate was 585 out of 1,243 persons. This subset of neonates showed that the frequency of admission to the NICU was significantly higher in the high-risk delivery group than in the non-high-risk delivery group, as was the frequency of stillbirth (Table 5).

## DISCUSSION

The total number of deliveries that occurred in our hospital for the 5 years from January 2009 through December 2013 was 1,935 cases. This number included a total of 1,138 (58.8%) cesarean sections; a number that is considerably higher than the average cesarean section rate in South Korea. Possible

**Table 2.** Maternal Underlying Disease

Underlying disease	Number of C-sec patients (%)
Diabetes mellitus	163 (14.3)
Hypertension	80 (7.0)
Hepatic disorder	57 (5.0)
Thyroid disorder	50 (4.4)
Pulmonary disorder	28 (2.5)
Morbid obesity (BMI > 40)	27 (2.4)
Cardiac disorder	13 (1.1)
Neurologic disorder	13 (1.1)
Renal disorder	9 (0.8)
Rheumatologic disorder	9 (0.8)
Hematologic disorder	8 (0.7)
Psychiatric disorder	5 (0.4)
Etc.	21 (1.8)

BMI: body mass index.

**Table 3.** Indications for Cesarean Section of Patients

Indication	Number of C-sec patients (%)
Previous cesarean section	463 (40.7)
Abnormal presentation (breech, transverse lie)	255 (22.4)
Fetal distress	210 (18.5)
Preeclampsia, eclampsia	152 (13.4)
Placenta previa	146 (12.8)
Progress failure	122 (10.7)
Multiple gestation	104 (9.1)
Placenta abruptio	82 (7.2)
Placenta accrete/increta	55 (4.8)
Fetal anomaly	55 (4.8)
Elderly primipara	21 (1.8)
Vasa previa	6 (0.5)
Uterine rupture	1 (0.1)
Etc.	26 (2.8)

**Table 4.** Clinical Outcomes between the Non-high-risk Group and the High-risk Group

	Non-high-risk group (N = 325)	High-risk group (N = 813)	P value
Anesthetic time (min)	67.0 ± 15.6	69.1 ± 21.1	NS
Operative time (min)	45.7 ± 14.7	47.5 ± 18.6	NS
EBL (ml)	438.6 ± 175.4	529.2 ± 354.3	< 0.001
Total fluid (ml)	915.3 ± 542.9	1,098.0 ± 783.6	< 0.001
Transfusion	6 (1.8%)	92 (11.3%)	< 0.001
Packed RBC (ml)	5.54 ± 42.7	58.8 ± 210.5	< 0.001
Additional drugs for uterine contraction	119 (36.6%)	439 (54.0%)	< 0.001

Values are mean ± SD or number of patients (%). EBL: estimated blood loss, RBC: red blood cells, NS: not significant.

**Table 5.** Clinical Outcomes of Neonates between the Non-high-risk Group and the High-risk Group

	Non-high-risk group (N = 325)	High-risk group (N = 918)	P value
Birth weight (g)	2,913.2 ± 681.1	2,520.1 ± 834.7	< 0.001
Apgar score 1 min	8.2 ± 1.5	7.5 ± 2.0	< 0.001
Apgar score 5 min	9.4 ± 1.2	8.9 ± 1.7	< 0.001
NICU admission	112 (34.5%)	473 (51.5%)	< 0.001
Still birth	2 (0.6%)	10 (1.1%)	< 0.001

Values are mean ± SD or number of patients (%). NICU: neonatal intensive care unit.

reasons for this result, in addition to the general increase in cesarean sections as mentioned above, were judged to include geographic characteristics of our hospital. Our hospital is the only tertiary medical center in the city area, and it is the only hospital with sufficient infrastructure for the treatment of high-risk delivery patients in the region. It also includes a NICU. Therefore, an important reason for an increase in the ratio of cesarean sections to total deliveries in our hospital may be the concentration of high-risk delivery patients in our hospital who are not distributed to other medical institutions.

The use of terms such as high-risk pregnancy, high-risk parturients, or high-risk delivery is often intermixed in clinics. In general, these concepts are used in all situations where the maternal and fetal risks increase during pregnancy or delivery, but the concrete definitions and categories slightly differ depending on the literature. Malinow and Ostheimer [5] regarded a parturient with preeclampsia/eclampsia, diabetes, premature birth, multiple gestation, infectious disease, existing neurological or cardiac disorder as a high-risk parturient; while Krilova [6] included existing or pregnancy-related medical conditions that are known to increase risk to the fetus, preeclampsia, diabetes, placenta previa, multiple gestation, intrauterine growth retardation, oligohydramnios and breech presentation. The current study decided to use the term

high-risk delivery as a concept that included the risks to the mother, the fetus, and the delivery itself; and high-risk delivery was defined according to the six risk factors mentioned above. The high-risk delivery group included 813 persons (71.4%), and this finding explains the high ratio of cesarean sections in our hospital. For a high-risk delivery, even though there is no indication for a cesarean section, there is a high tendency to use a cesarean section for risk management of the parturient and neonate. Management for parturients with hypertension during pregnancy, on principle, includes a vaginal delivery attempt unless there are special contraindications [7], but many of these patients deliver by cesarean section. According to Bang et al. [8], 82.9% of parturients with hypertension received cesarean sections for the 10 years from 1998 through 2007. In addition, cesarean section deliveries accounted for a high ratio to total deliveries because there were many cases in which emergency delivery was necessary due to the disease itself or a complication. It has been reported recently that the frequency of planned cesarean sections has increased due to an increase of elderly mothers and social issues. In this study also, the total number of patients with hypertension as an underlying disease who received a cesarean section was 7%, and for eclampsia/ preeclampsia patients it was 13.4%; this had an impact on the increase of the ratio of cesarean sections.

In our study, there were no significant differences between the anesthesia time and operative time between the non-high-risk delivery group and the high-risk delivery group. However, the high-risk delivery group had a relatively higher risk of cesarean section. In other words, in the high-risk delivery group, there were higher estimated blood losses, higher amounts of infusion solution administered during surgery, higher frequencies of blood transfusion and amounts of red blood cell concentrate transfusions than in the non-high-risk delivery group; and there was a significantly higher administration of additional uterotonic medication. This result shows that the increased risk of massive hemorrhage that causes rapid hemodynamic instability, and the failure of uterine contractions are relatively high in cesarean sections of high-risk delivery patients. Thus, thorough preoperative communication with the obstetrician to determine the patient risk level should be clarified in advance. In addition, sufficient preparation such as fast additional intravenous line insertion, sufficient fluid and blood preparation, appropriate drug preparation, and appropriate anesthetic management from anesthesiologists with experience are required.

Study results showed that cesarean delivery neonates born to mothers in the high-risk delivery group had significantly lower birth weights, and lower 1 and 5 minutes Apgar scores as compared to neonates born to mothers in the non-high-risk delivery group. They also had significantly higher admissions to the NICU as well as a higher risk for stillbirth. This result supports the general expectation that babies born to a high-risk delivery mother are expected to be in worse condition. This study included 210 cases where a cesarean section was performed due to fetal distress; this included 18.5% of the total number of cesarean sections, a considerable proportion. Krilova [6] reported that when low Apgar scores, birth to a small-for-gestational-age neonate, and a requirement for advanced level nursery care of neonates born to a high-risk mother and a non-high-risk mother were compared, those born to high-risk mothers had worse clinical outcomes. During anesthesia for cesarean sections of high-risk delivery patients, anesthesiologists should manage hemorrhage and hemodynamic instabilities occurring during the delivery of placenta; manage the process of uterine contractions effectively; and carry out additional treatments for neonatal conditions, if necessary. Since effective treatment is immediately necessary for severely suppressed neonates to avoid neurological damage, equipment such as a warmer and aspirator for neonates, oxygenator, monitor for vital signs, endotracheal intubation equipment, and emergency

resuscitation drugs should be prepared in advance. It is also necessary to have sufficient knowledge about the management of neonates and CPR capability [9].

This study included 1,037 persons (91.2%) who received general anesthesia for cesarean sections in our hospital, which accounted for more persons than received regional anesthesia. In general, regional anesthesia is the recommended anesthesia for cesarean sections. Regional anesthesia can avoid the potentially difficult maternal airway management, the risk of pulmonary aspiration, and the risk of cerebral hemorrhage and pulmonary edema due to hypertension during intubation or extubation [10-14]. However, a recent meta-analysis reported that neuroaxial anesthesia did not hold an advantage compared to general anesthesia in major maternal or neonatal outcomes [15]. Regional anesthesia is contraindicated in instances of existing maternal neurologic disorders, coagulopathies, severe hypovolemia, or infection; in cases of not enough time for regional anesthesia; in cases with expected massive maternal hemorrhage; a patient's refusal; and failure of regional anesthesia. In these cases, general anesthesia should be carried out instead of regional anesthesia [16,17]. Our center has a high proportion of high-risk deliveries and emergency cesarean sections. In urgent situations where there is not enough time for regional anesthesia induction to take place, both obstetricians and anesthesiologists preferred general anesthesia.

This study has some limitations. We only compared the high-risk delivery group to the non-high-risk delivery group. The differences in clinical outcomes between the two groups were expected to a certain extent, and they were only used to enhance the results of previous studies. Therefore, we have plans to conduct subsequent studies to evaluate the outcomes and prognosis of parturients and neonates in high-risk delivery groups according to the number of the risk factors they have.

As discussed above, anesthetic management of cesarean section requires a thorough understanding and preparation because of the basic maternal anatomical and physiological changes, risks of massive maternal hemorrhage or hemodynamic instability, the necessity of neonate treatment immediately after delivery, and the high frequency of emergency surgery. Especially for high-risk delivery, professional anesthetic management is necessary. High-risk delivery has a relatively high frequency of massive maternal hemorrhage and insufficient uterine contraction patterns that cause hemodynamic instability within a short surgical time (about one hour). In addition, since neonates born to high-risk delivery mothers require a separate treatment to be carried out simultaneously with

anesthetic management of the mothers, there is a great difficulty in anesthetic management. Therefore, since there is a host of possibilities for massive maternal hemorrhage within a short time and hemodynamic instability in high-risk delivery patients, obstetric anesthesiologists should monitor the amount of blood loss and vital signs carefully; and prepare blood products, volume expanders, and vasoconstrictors in case of urgent situations. Neonates from high-risk delivery patients had relatively unfavorable outcomes compared with non-high-risk delivery patients. Thus, anesthesiologists need to prepare the equipment and drugs necessary for neonatal resuscitation in advance. In addition, anesthesiologists and obstetricians need to consult with pediatricians preliminarily if the neonatal status was not expected to be favorable or intensive care for both the mother and neonates was predicted.

## REFERENCES

- Kim YN, Kang YM, Gil MK, Kim SY, Jeong DH, Lee KB, et al. Chronological pattern of the frequencies and indications for cesarean section: analysis of 6,051 cesarean section cases at Busan Paik hospital for 24 years, 1980-2003 -. *Korean J Obstet Gynecol* 2005; 48: 2080-90.
- Yuk JS, Kim SH, Kim PS, Park CH, Hong SY, Shin JW, et al. A study for pertinence in emergent cesarean section. *Korean J Obstet Gynecol* 2005; 48: 21-8.
- National Health Insurance Service. Cesarean section trend in 2000. 2001. 5. Available from [http://download.mw.go.kr/front\\_new/modules/download.jsp?BOARD\\_ID=140&CONT\\_SEQ=20274&FILE\\_SEQ=6018](http://download.mw.go.kr/front_new/modules/download.jsp?BOARD_ID=140&CONT_SEQ=20274&FILE_SEQ=6018)
- Health Insurance Review & Assessment Service. Adequacy assessment result of cesarean section in 2012. 2012. 12. Available from <http://www.ksog.org/bbs/skin/notice/download.php?code=info07&number=431>
- Malinow AM, Ostheimer GW. Anesthesia for the high-risk parturient. *Obstet Gynecol* 1987; 69: 951-64.
- Krilova Y. Chances of adverse neonatal outcome in high-risk and low-risk obstetrical patients. *Clin Med Insights Womens Health* 2008; 1: 3-14.
- Korean Society of Obstetrics and Gynecology. *Obstetrics*. 4th ed. Seoul, Koonja Publishing Inc. 2007, pp 725-60.
- Bang EC, Lee HS, Kang YI, Cho KS, Kim SY, Kim JY. Clinical evaluation of anesthesia for cesarean section of the patients with hypertensive disorders in pregnancy: retrospective study for 10 years. *Anesth Pain Med* 2009; 4: 341-7.
- The Korean Society of Anesthesiologists. *Anesthesiology and Pain Medicine*. 3rd ed. Seoul, Ryomoongak Publishers. 2014, p 438.
- Bucklin BA, Hawkins JL, Anderson JR, Ullrich FA. Obstetric anesthesia workforce survey: twenty-year update. *Anesthesiology* 2005; 103: 645-53.
- Cyna AM, Dodd J. Clinical update: obstetric anaesthesia. *Lancet* 2007; 370: 640-2.
- Bloom SL, Spong CY, Weiner SJ, Landon MB, Rouse DJ, Varner MW, et al. Complications of anesthesia for cesarean delivery. *Obstet Gynecol* 2005; 106: 281-7.
- Cheek TG, Samuels P. Pregnancy-induced hypertension. In: *Anesthetic and Obstetric Management of High-Risk Pregnancy*. 2nd ed. Edited by Datta S: St. Louis, Mosby. 1996, pp 386-411.
- Hawkins J. Anesthesia and preeclampsia/eclampsia. In: *Obstetric Anesthesia*. 2nd ed. Edited by Norris MC: Philadelphia, Lippincott Williams & Wilkins. 1999, pp 501-23.
- Afolabi BB, Lesi FE. Regional versus general anaesthesia for caesarean section. *Cochrane Database Syst Rev* 2012; 10: CD004350.
- The Korean Society of Anesthesiologists. *Anesthesiology and Pain Medicine*. 3rd ed. Seoul, Ryomoongak Publishers. 2014, p 431.
- Livingstone HL, Dresner M. Anaesthesia for obstetric surgery. *Curr Anaesth Crit Care* 2006; 17: 143-50.