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Review

General anesthesia for cesarean section: are we doing it well?

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Korea has a higher rate of cesarean sections under general anesthesia than in other countries. Neuraxial anesthesia is the gold standard for a cesarean section, but there are some cases in which general anesthesia is inevitable. Therefore, obstetric anesthesiologists should be familiar in performing general anesthesia for cesarean section. Rapid-sequence induction and intubation with cricoid pressure using thiopental-succinylcholine have been the standard for cesarean section under general anesthesia for a long time. Recently, with the introduction of new drugs (propofol, rocuronium, and sugammadex) and equipments (videolaryngoscopy and supraglottic airways), anesthesia methods have also gradually changed. Pursuing the safety of obstetric patients and anesthesiologists at the same time, this review will help update the knowledge or training in performing general anesthesia for cesarean section.

Keywords: Cesarean section; General anesthesia; Obstetrics; Rapid sequence induction.

INTRODUCTION

Approximately one-third of all new-borns in Korea are delivered via cesarean section [1]. World Health Organization (WHO) considers the ideal rate for cesarean sections to be between 10 to 15% of total childbirths. However, there has been an explosive rise in the rate of cesarean sections worldwide. In some countries, the current cesarean section rate exceeds 50% [2].

Anesthesiologists should choose between general or regional anesthesia depending on the individual patient's condition and clinical situation. The use of appropriate and effective anesthesia for cesarean section is important not only to reduce the incidence of maternal and fetal morbidities but also to reduce the incidence of intraoperative maternal awareness.

Neuraxial anesthesia is currently recommended as the gold standard rather than general anesthesia for most patients undergoing cesarean section [3,4], since the mortality rate of cesarean section under general anesthesia is 16.7 times higher than that under regional anesthesia [5].

There is no consensus on the ideal proportion of general anesthesia for cesarean sections, but approximately 5–6% are conducted under general anesthesia, which can be further reduced by obstetric anesthesiologist teams or obstetric specialized anesthesiologists [6,7]. However, in patients with emergent conditions (e.g., placental abruption, cord prolapse, antenatal placental bleeding, and non-reassuring fetal tracing), the rate of general anesthesia has been reported to be up to 20% [8]. Except for emergencies, induction of general anesthesia will continue in situations deemed “unavoidable and necessary,” including patient refusals or contraindications to neuraxial anesthesia [9].

As the overall safety of general anesthesia has significantly improved over the past two decades with newly developed drugs, devices, and monitors, general anesthesia no longer has an impact on anesthesia-related maternal mortality rates [10,11]. In addition, general anesthesia is valuable in clinical obstetric conditions that require hemodynamic stability or rapid induction of anesthesia [12]. General anesthesia for cesarean sections was not associated with overall neurodevelopmental delay at two years of age [13].

The choice of general anesthesia varies across countries or hospitals. In Korea, unlike previous data from the United Kingdom or the United States, the rate of general anesthesia use is steadily decreasing with time, but it is still over 20% [14]. In some hospitals with a high volume of emergency cases or high-risk parturients, the rate of general anesthesia is close to 90% [15]. Racial, ethnic, and socioeconomic disparities also contribute to the choice of general anesthesia [11].

Opportunities for training in obstetric airway management have declined over the past four decades. A retrospective audit conducted by a single British institution reported that the use of general anesthesia for cesarean section decreased from 76% in 1982 to 7.7% in 1998 and 4.9% in 2006 [16,17]. With the worldwide declining trend of general anesthesia for cesarean sections, it is estimated that many residents/trainees will graduate without experience in inducing general anesthesia on pregnant women [18]. Reduced or biased cases of general anesthesia can deprive them of training experience and eventually affect patient safety. Continuous education and training are essential to ensure safe anesthesia. Unfortunately, most anesthesiologists base their management to previous experiences and partly outdated approaches. It is necessary to update our knowledge to provide safe anesthesia for cesarean section, especially in Korea, which has low fertility rates.

For anesthesiologists in varied settings, this review will help to update the knowledge or training in general anesthesia for cesarean section.

INDUCTION

Rapid-sequence induction and intubation (RSII) with cricoid pressure using thiopental and succinylcholine has been the standard of general anesthesia for cesarean sections for a long time.

Intravenous induction agents

In the past, a single dose of thiopental was recommended as the induction agent of choice for general anesthesia in cesarean section; however, many textbooks or guidelines also recommend propofol. In fact, this would have been affected more by the current state that thiopental is no longer available in the United States. There is more evidence of a shift in propofol use [19], which is probably similar worldwide. However, it is highly likely to be used off-label because it is not licensed in many countries except the United States [20,21]. It has also not been approved for obstetric anesthesia in Korea. This needs to be corrected in the future. Except for propofol, most drugs used in obstetric anesthesia are permitted to be administered only if the therapeutic benefits exceed the risk.

The recommended dose of thiopental varies depending on the textbooks or guidelines, but it is approximately 4–6 mg/kg and has little effect on neonates up to 6 mg/kg [22,23]. Thiopental 7 mg/kg is superior to 5 mg/kg in creating a deeper hypnotic state in the parturient. However, it negatively affects Apgar scores and neonatal neurobehavioral tests [24].

Induction agents administered to the parturient are transferred to the fetus through the placenta. When a neonatologist is not present at delivery, it would be prudent to reduce the doses of induction agents to the lowest possible and to shorten the duration from the administration of anesthetics to delivery of a baby. However, initiating surgery without providing sufficient anesthesia increases the risk of the mother becoming aware of and developing tachycardia and hypertension.

During general anesthesia for cesarean section, anesthesiologists should pay attention to intraoperative maternal awareness, which shows a relatively high incidence of awareness compared to other surgeries [25]. The use of thiopental is one of the causes of awareness during cesarean sections under general anesthesia [25]. If intubated using small doses of thiopental, additional inhalational anesthetics may be required before the baby is delivered.

In terms of anesthetic depth, propofol seems to be better than thiopental [26]. The recommended dose of propofol is approximately 2.0–2.8 mg/kg. However, propofol 2.5 mg/kg is a sufficient dose for induction to prevent maternal awareness; it causes worse baby outcomes and higher reduction in maternal blood pressure than thiopental does [27,28]. Furthermore, propofol 2 mg/kg compared with thiopental 4 mg/kg tends to have a higher incidence of Apgar scores of 7 or less [29]. Although it depends on the dose of propofol used, the prevailing opinion is that propofol is associated with a worse neonatal profile. Therefore, propofol should be used with caution in limited cases until the supply of thiopental is terminated, for example, in the presence of a medical staff to take care of the neonate entirely, in case of a hypertensive parturient or reduced dose usage.

In the presence of hemodynamic instability, ketamine (1–1.5 mg/kg), or etomidate (0.3–0.5 mg/kg) may be used in the presence of hemodynamic instability. The addition of a low dose of ketamine to thiopental is associated with better sedation and lower analgesic requirements, without side effects [30,31].

Neuromuscular blocking agents

Until recently, succinylcholine 1–1.5 mg/kg was the standard treatment used for RSII because of its rapid onset. The only reason succinylcholine has been used since a long time is probably because it is relatively safe.

In fact, for cesarean section, there is a high risk of complications related to airway management (aspiration pneumonia, hypoxia, etc.) and a high incidence of difficult or failed intubation [19]. Therefore, succinylcholine remains the first choice for cesarean section, although its use is being discontinued because of rare but fatal side effects such as malignant hyperthermia and hyperkalemia. In addition, owing to the short duration of action of succinylcholine, spontaneous breathing can be quickly resumed if intubation is difficult or even fails.

Recently, rocuronium has replaced succinylcholine as the first choice with the introduction of sugammadex, which can be immediately reversed because the onset time is similar to that of succinylcholine [32]. However, the recommended dose of rocuronium remains controversial. Pühringer et al. [33] reported that rocuronium 0.6 mg/kg provides clinically acceptable intubating conditions because of the higher cardiac output in parturients. In contrast, McGuigan et al. [32] suggested a higher dose of 1 mg/kg of rocuronium to achieve faster and better intubation conditions without increasing the dose of hypnotics and consequently without compromising hemodynamic stability.

Due to the short duration of a cesarean section, the duration of action of rocuronium can be prolonged, and sugammadex may eventually be used. If the neuromuscular monitoring is performed and the appropriate dose of sugammadex is given adequately, rocuronium 1.0 mg/kg is considered as an appropriate dosage for RSII. However, anesthesiologists should pay attention to not administer a large amount of rocuronium because its fetal/maternal plasma drug concentration ratio is about 0.16 [23] compared to succinylcholine, which is quickly metabolized and is not detected in the fetal vein in about 5–10 min [34].

Cricoid pressure

Cricoid pressure, also known as the Sellick maneuver, to prevent pulmonary aspiration, is widely used in RSII [20]. Some textbooks also recommend a more accurate (10 N while awake; increased to 30 N after loss of consciousness) cricoid pressure [35,36]. However, some studies have indicated that cricoid pressure is difficult to apply because it is difficult to compress the cricoid cartilage efficiently and causes discomfort in conscious patients [37]. In addition, questions have been raised regarding the effectiveness of cricoid pressure in preventing aspiration [38]. It is necessary to apply cricoid pressure in patients at a high risk of aspiration so that it can be appropriately provided with sufficient force. Ideally, pressure should be applied on the cricoid cartilage towards the body of C6 directed at 90° to the tilted table.

Videolaryngoscopy and supraglottic airways

The most important recent changes in difficult airway management are the introduction of videolaryngoscopy (VL) and supraglottic airways (SGA).

The usefulness of VL has already been demonstrated in adults who require intubation [39] and especially in obese patients [40]. This supports its increased adoption in obstetrics, where VL, rather than direct laryngoscopy, is recommended as the first attempt at intubation for all obstetric patients [36,41].

SGAs play an important role in the airway management. Unlike VL, SGAs enable ventilation even in patients with difficult facemask ventilation and simultaneous use as a conduit for tracheal intubation [42]. Therefore, the use of SGAs is now widely recommended in many guidelines for difficult airway algorithms [43–45]. Although SGAs are reasonable alternatives to endotracheal intubation, they are not recommended as the first line for elective cesarean section [36], but are recommended as a device for rescue ventilation. For pregnant patients, the use of second-generation SGAs is recommended rather than first-generation SGAs when used for rescue ventilation after difficult airway management [46]. The risk of regurgitation and pulmonary aspiration may be reduced by aspirating the gastric tube passing through the

SGA and minimizing the fundal pressure at delivery [46].

MAINTENANCE

The goals for anesthetic maintenance include (1) appropriate depth of anesthesia to prevent awareness and recall, (2) minimal adverse effects on the neonate, and (3) minimal effects on uterine contractions after delivery. These goals can be accomplished using inhalational anesthesia or, less commonly, total intravenous anesthesia (TIVA).

To minimize neonatal depression and its effect on uterine tone, an end-tidal minimum alveolar concentration (MAC) of inhalational anesthetics (0.5) has been traditionally used for cesarean section under general anesthesia. However, the use of a higher MAC is not necessarily associated with increased neonatal depression [47]. For an appropriate depth of anesthesia, the gap between the intravenous induction agent and inhalational anesthetics should be reduced. Therefore, to minimize this gap, adequate MAC should be achieved as soon as possible, for example, by using a high initial concentration of volatile agent combined with high fresh gas flows [48] or the additional use of nitrous oxide as a carrier gas. Nitrous oxide can reduce inhalational anesthetic requirements and does not decrease uterine tone. Nitrous oxide is rapidly transferred across the placenta, where fetal tissue uptake reduces the fetal arterial concentration for the first 20 min [49]. Theoretically, there is a risk of diffusion hypoxia; therefore, if it takes time from incision to delivery, lowering the concentration of nitrous oxide used or administering 100% oxygen should also be considered. Inhalational anesthetics produce dose-dependent uterine relaxation [50], which can result in uterine atony and hemorrhage. When high concentrations of inhalational anesthetics are used, uterotonic agents should be used to maintain the uterine tone.

After delivery, once the fetal transfer of medication is no longer a concern, a short-acting benzodiazepine (e.g., midazolam), a short-acting opioid (e.g., fentanyl, alfentanil, or remifentanil), and/or nitrous oxide 50–70% can be added to allow a reduced dose of inhalational anesthetics to 0.5–0.75 MAC. Conversely, TIVA can replace inhalational anesthetics. Currently, propofol is the only drug that can be used for TIVA. Propofol can relax the uterus less than inhalational anesthetics [51].

All opioids, particularly those with high lipid solubility (e.g., remifentanil, fentanyl, and sufentanil), readily pass through the placenta to the fetus. Consequently, opioid administration is usually avoided until after delivery to reduce the risk of neonatal depression.

Dexmedetomidine has recently been reported to enhance oxytocin-induced contractions and is expected to be used as a sedative after fetal delivery in the future [51].

RECOVERY

Extubation should be performed with the patient fully awake while maintaining airway reflexes because anesthesia-related deaths from airway obstruction or hypoventilation occur during emergence and recovery, and not during the induction of general anesthesia [52]. After surgery, the patient should still be kept in a closely monitored environment.

CONCLUSIONS

To date, RSII with cricoid pressure is the standard procedure for cesarean section under general anesthesia. It has been used safely for a long time with thiopental-succinylcholine-inhalational anesthetics and has not undergone procedural changes. However, induction of general anesthesia for cesarean section is relatively uncommon worldwide; hence, trainees have lesser experience with general anesthesia now than they had in the past. Therefore, it is essential that all obstetric anesthesiologists maintain their skills by regularly practicing drills, including perioperative difficult/failed airway management, and updating their knowledge of drugs, instruments, monitors, and even legal permissions.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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