Anesthesia for Cesarean Section

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1. Introduction

Cesarean section is frequently becoming a popular mode of child delivery world-wide. The rate of Cesarean section could be as high as 18/100 in Africa (Aisien et al, 2002) to 32/100 deliveries in the United States (Declercq et al, 2011). The use of anesthesia makes a Cesarean delivery possible. Various forms of anesthesia have been used to perform this surgery. However, the use of general anesthesia has fallen dramatically in the past few decades and now accounts for only about 5 percent of Cesarean deliveries in the United States and United Kingdom. In the sub-saharan Africa, 80 -90% of the Cesarean sections are performed under spinal anesthesia (Fyneface-Ogan et al, 2005). Although spinal analgesia is now the mainstay of anesthesia in countries like India and parts of Africa, excluding the major centres, current usage of this technique is waning in the developed world, with epidural analgesia or combined spinal-epidural anesthesia emerging as the techniques of choice where the cost of the disposable 'kit' is not a challenge.

This chapter endeavors to take an in-depth review of anesthesia for Cesarean section. Although the trend for anesthesia for Cesarean section is towards the use of a combined spinal-epidural technique (Rawal et al, 2000), other options of anesthesia will be reviewed with the intent to highlight the importance of safety during the procedure.

2. Preoperative evaluation and management

The essence of preoperative evaluation of the pregnant woman is in order to delineate the potential difficulties in the line of the anesthetic management and; allay any anxiety associated with the procedure. The paradigm of preoperative assessment is now shifting from predicting risk or anticipated difficulty to actively managing it.

2.1 Preoperative visit

Preoperative evaluation of parturients undergoing Cesarean section is well regarded as a vital part of their care (Garcia-Migel et al 2003). This evaluation forms part of the clinical investigation carried out before anesthesia for Cesarean section and it is the sole responsibility of the attending Anesthetist. It is well known that preoperative visit and proper evaluation create trust and confidence in parturients (Association of Anesthetists of Great Britain and Ireland [AAGBI], 2001).

The aims of preoperative visit and assessment include:

- to reduce the risk associated with Cesarean section and anesthesia
- to increase the quality (thus reducing the cost) of peroperative care (AAGBI, 2001)
- to restore the parturient to the desired functional level
- to obtain the parturient's informed consent for anesthetic procedure

Preoperative Evaluation and Management

Generally, parturients are very apprehensive and becoming more sophisticated particularly as they now have access to clinical information. Therefore, high quality clinical information is now a clear requirement as shared decision-making is frequently encouraged. For parturients, both written and verbal information should be provided as regards how it affects them and their babies. In the United Kingdom (Department of Health, 2001), it is not acceptable for parturients to be denied any information about anesthesia until the time of preoperative visit; at such stage the parturient will not be in a position genuinely to make a decision. Every information made available to parturients should be clearly understood explaining every technical detail. Such information should address the side effects and complications associated. Evidence supports the shift in trend of practice towards shared decision-making, where patients are encouraged to express their views and participate in making clinical decisions (Frosch and Kaplan, 1999). Patients are also becoming more informed about the various options available in anesthetic care and their participatory role in treatment outcome. With this rising trend of patients' involvement, the preferred anesthetic care maybe the sole decision of the parturient (Fyneface-Ogan et al, 2009).

A proper preoperative evaluation of the parturient before anesthesia and Cesarean section is aimed at;

- improving outcome
- identifying potential anesthetic difficulties
- identifying existing medical conditions
- improving safety by assessing and quantifying risk
- allowing planning of preoperative care
- providing the opportunity for explanation and discussion
- allaying anxiety and fear

An interaction with the pregnant patient during the preoperative visit and evaluation may reveal allergies, undesirable side effects of medications or other agents, known medical problems, surgical history, major psychological/physical traumas and current medications. A focused evaluation of the patient may also reveal depleted cardiopulmonary function, poor homeostatic status, personal or family history of anesthetic problems, smoking and alcohol habits.

Questionnaires aimed at generating basic background information have been developed (AAGBI, 2001). These have been found to improve efficiency in the preoperative clinics. Options are available to patients to fill the questionnaires immediately or at the end of last antenatal visit. This questionnaire does not serve as a substitute to proper history taking and clinical evaluation of the patient.

A complete physical examination of the pregnant woman is required to ascertain the possibilities of an existing potential difficulty. Such difficulty could present special challenge during procedures like airway manipulation, establishing a neuraxial block, venous access etc. The presence of any of these potential difficulties might persuade the attending Anesthetist to favor either general or regional anesthesia.

Airway difficulties associated with failed intubation are very common in obstetric patients (approximately 1:238 compared with 1:2220 in non-pregnant population) (Rahman and Jenkin, 2005). Failed intubation reflects the relatively high incidence in the pregnant population. This high incidence among parturients could be due to changes in soft tissues of the airway mucosa, swollen and engorged breasts along with full dentition. Therefore it is imperative to try and identify beforehand airway that is likely to prove difficult. Some bedside assessments are carried out to identify potential airway problems but unfortunately these tests have very low predictive values amongst obstetric patients. Generally, difficult intubation is frequently common in parturients with the following physical characteristics:

- inability to see the uvula or soft palate when the patient is asked to open her mouth and protrude her tongue in a sitting position (Mallampati class III and IV) (Mallampati et al, 1985)
- receding mandible
- protruding maxillary incisors
- a short neck (Rocke et al, 1992)
- keeping a packed African hair style (Famewo, 1982)

Nevertheless, the management of the airway is the responsibility of the attending Anesthetist. It is important to note that a difficult airway exists when the attending Anesthetist has difficulties with mask ventilation, tracheal intubation or both. The incidence of mask ventilation is 5% (CI: 3.9-6.1) (Langeron et al 2000). However, a poorly managed airway may be associated with airway trauma or cardiac or neurological hypoxic injury.

Except in the presence of intercurrent medical disease(s), the routine laboratory investigations preceding anesthesia and Cesarean section are few. The requested laboratory investigations are requested for on clinical grounds. Routine investigations carried out include hemoglobin check, grouping and cross-matching of blood, platelet count. However cross-matching of blood that is not transfused consumes blood bank resource unnecessarily increases the blood inventory that must be maintained, and increases the number of units that become outdated. Occasionally, for example, if a massive hemorrhage is anticipated following Cesarean section, this may be a deliberate policy. Therefore the maximum surgical blood order schedule suggests that, for patients with a high likelihood of blood transfusion, the number of units cross-matched be twice the median requirement for that surgical procedure (crossmatch-to-transfusion ratio of 2:1) (Friedman et al 1976). However a recent study suggests that the crossmatch-to-transfusion ratio may be reduced with the introduction of a Patient-Specific Blood Ordering System that estimates a postoperative hematocrit using the patients' blood volume, the surgeon-defined expected blood loss and preoperative hematocrit (Palmer et al, 2003).

2.2 Premedication

Premedication may be an important component of obstetric anesthesia practice. It may allay the parturient's anxiety (Leigh et al, 1977), alleviate preoperative pain, reduce the pain of vascular canulation or regional anesthesia, reduce nausea and vomiting, minimize risk of aspiration, act as an antisialogogue or facilitate a smooth anesthetic induction. Therefore where these effects are desired, premedication should be prescribed, be correctly given and be effective.

Premedication is known to block the preoperative stress response and lowers beta-endorphin levels in these parturients (Walsh et al, 1987). Following premedication, anesthesia induction is aided by concomitant sedative premedication. However, it is common to withhold premedication from patients having Cesarean section on the grounds that the agents including opioids cause depression of the newborn. The effects of most of the agents used for premedication are readily reversible; therefore there is no scientific evidence in support of withdrawal of premedicants.

2.3 Fasting and prophylaxis against acid aspiration

Parturients are at risk of gastric aspiration under general anesthesia. A high incidence of aspiration of 1:900 during Cesarean section and 1:9200 parturients, with no fatalities, have been reported (Soriede et al, 1996). The altered physiological state in pregnancy is associated with alterations in the rate of gastric emptying and the competence of the gastro-esophageal barrier. The reduction in competence of the barrier is worse in parturients under general anesthesia leading to increased risk of regurgitation and pulmonary aspiration due to retention of gastric contents. The presence of severe pain, and inadequate starvation could result in reduced gastric emptying. The physiological mechanisms that prevent regurgitation and aspiration include the lower esophageal sphincter (LES), and the upper esophageal sphincter (UES) tones, and depressed laryngeal reflexes. It is important to appreciate how these mechanisms may be impaired so that the risk of aspiration pneumonitis can be minimized.

The LES forms the border between the stomach and the esophagus. At this point, the left margin of the lower esophagus makes an acute angle with the gastric fundus and contraction of the right crus of the diaphragm forms a sling around the abdominal esophagus.

Fasting before the administration of anesthetics in parturients aims to reduce the volume and acidity of the stomach contents during surgery, thus reducing the risk of regurgitation and pulmonary aspiration. The former two involve adequate fasting, a decrease in gastric acidity, facilitation of gastric drainage, and maintenance of a competent LES, although the latter two factors may require tracheal intubation or the use of other airway devices and application of cricoid pressure. With the exception of ketamine, most anesthetic techniques are likely to reduce UES tone and increase the likelihood of regurgitation of material from esophagus into the hypopharynx.

Recent guidelines recommended a shift in the fasting policy from the standard “nil by mouth from midnight” approach to a more relaxed policy which permits a period of restricted intake up to a few hours before surgery (Brady et al 2003). Liberal preoperating fasting routines are now frequently implemented world-wide. In general, clear fluids are allowed up to two hours before anesthesia, and light meals up to six hours. Although parturients have traditionally been denied food and drink for 6 hours before induction of general anesthesia, where this “time-line” originated from is not clear. In addition, there is insufficient evidence to address the safety of preoperative fasting for solids although a conscious opinion of a fasting period of 6 hours for a light meal, such as tea and toast is well established (ASA Task Force, 1999).

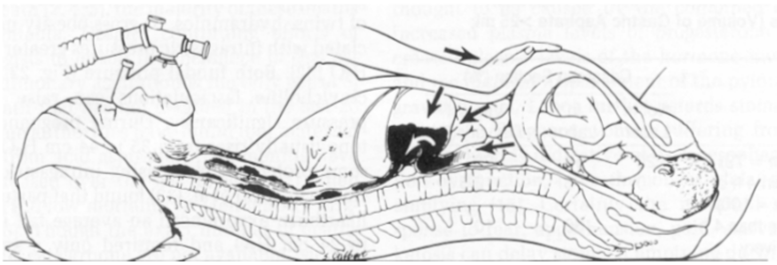

Fig. 1. Regurgitation of stomach content under general anesthesia

All pregnant women from the second trimester develop an increased risk of regurgitation of stomach contents. At the time of delivery there is a chance of requiring general anesthesia, which may often be required in a non-starved woman, and therefore a risk of pulmonary aspiration. Aspiration of gastric contents is a rare but potentially serious adverse event. It is much commoner in the pregnant population undergoing general anesthesia for Cesarean section. Emphasis should be to deliver the safest anesthetic care to the pregnant woman while balancing all relevant risks.

The identification of predisposing factors for pulmonary aspiration is paramount in its prevention. Risk factors include increased gastric pressure, increased tendency to regurgitate, and laryngeal incompetence (Engelhardt & Webster, 1999). Contrary to vomiting, which is an active process, regurgitation is passive in nature. Pulmonary consequences of gastric aspiration fall into three groups:

i. particle-related
ii. acid-related
iii. bacterial

Particle-related complications may result in acute airway obstruction leading to arterial hypoxemia and may cause immediate death. The harmful effects of acid aspiration may occur in two phases:

i. immediate direct tissue injury
ii. subsequent inflammatory response (Knight et al, 1992).

Gastric contents are not sterile and infection with bacteria following aspiration may result in pneumonia (Johanson & Harris).

In the management and prevention of gastric aspiration, all parturients should be considered to be at high risk of requiring anesthetic intervention. Outcomes recorded in birth centres caring for even low risk pregnancies, where all women were allowed to eat and drink as they desired, have shown 15.4% required transfer to another hospital and 4.4 % required Cesarean delivery (Rooks et al 1989). Risk of aspiration is a function of those factors which influence gastric volume and pH, opioid effects, the experience and expertise of the anesthetist managing the airway, as well as maternal obesity (Lewis 2007; McClure & Cooper 2005).

Although the incidence of aspiration in pregnant women has changed over recent decades, it now occurs less frequently. This reduced frequency could be due to the high rates of use of regional anesthesia for Cesarean section. The tendency for this gastro-respiratory accident is more in the parturients due to both hormonal and mechanical factors. Significant risk factors for aspiration include the presence of food and opioid analgesia in labor (Murphy et al 1984; Wright 1992,). Loss of consciousness and sedation contribute to these risks.

The diagnosis of gastric aspiration is seldom a problem, the clinical features being those described by Mendelson (Mendelson 1946), namely progressive dyspnea, hypoxia, bronchial wheeze and patchy consolidation and collapse in the lungs, all following the inhalation of gastric contents during the course of general anesthesia. Although the disease manifests in the same way all through the years, the prognosis has improved over the years in the developed world.

Aspiration when it occurs remains an important cause of death and morbidity. Aspiration pneumonitis carries a 30-percent mortality rate and accounts for up to 20 percent of all deaths attributable to anesthesia. In the US between 1979 and 1990, 23% of maternal deaths were found to be due to aspiration (Hawkins et al 1997). Over the years, the introduction of several measures designed to reduce the risk of aspiration in pregnant women have been associated with a profound effect in reducing mortality from aspiration. Popularization of regional anesthesia, fasting in labor, use of antacid premedication, prokinetics, H2-blockers, mechanical factors such as cricoid pressure, intubation with cuffed tracheal tubes and have all been identified as contributing to the dramatic fall in maternal mortality (Cooper et al 2002).

Gastric content values of volume and pH, and competence of lower esophageal tone play major role in the occurrence of aspiration. Risk of pneumonitis is said to occur when there is a combination of pH less than 2.5 and a volume greater than 25 ml of stomach contents. For the pregnant woman, the critical values of gastric contents are a pH value of <2.5 and a volume of >0.4 ml/kg.

Certain factors contribute to the risk of aspiration in parturients. Although it has been contentious as to whether gastric emptying and gastric pH are decreased throughout pregnancy, it is well known that gastric emptying is delayed during labor and delivery. In addition, anatomic changes resulting from displacement of the stomach by the pregnant uterus and decreased lower esophageal sphincter tone, caused by increased progesterone levels, produce an increased incidence of gastroesophageal reflux in the pregnant woman.

Weight gain in pregnancy contributes immensely towards difficulty in airway management and in addition, is associated with a significantly higher gastric volume in labor (Roberts & Shirley 1974). Another major key player in causing a delay in the gastric emptying follows the administration of parenteral opioids during late pregnancy and labor (Nimmo et al 1975). Opioids administered epidurally or intrathecally in labor may also have this effect, although it would appear to be dose-dependent. It has been shown that gastric emptying could be delayed in parturients who had received a high dose of fentanyl by epidural infusion (Porter et al 1997).

Following the severe morbidity and mortality associated with aspiration pneumonitis, its preventative strategies should aim at increasing the pH and/or reduce intragastric volume. Many preparations such as antacids, prokinetic, mechanically emptying the stomach using a naso-gastric tube are in use either alone or in combination (Paranjothy et al 2011).

It is, therefore, suggested that oral ranitidine 150 mg should be administered 2 hours before an elective Cesarean section and preferably 150 mg the previous evening. As part of the preparation for an emergency Cesarean section an intravenous ranitidine 150 mg with 30 ml of freshly prepared 0.3 molar solution of sodium citrate should be given 30-60 minutes before surgery. Other usual precautions to avoid acid aspiration should also be taken.

2.3.1 Mechanical suctioning

Medical suction is an essential part of clinical practice. Since the 1920s, it has been used to empty the stomach, and in the 1950s, airway suction levels were first regulated for safety. Ideally, clinicians need the best flow rate out of a vacuum system at the lowest negative pressure. Three main factors affect the flow rate of a suction system:

- The amount of negative pressure (vacuum)
- The resistance of the suction system
- The viscosity of the matter being removed

The negative pressure used establishes the pressure gradient that will move air, fluid, or secretions. Material will move from an area of higher pressure in the patient to an area of lower pressure in the suction apparatus. A naso-gastric tube is passed into the parturient with the aim of the tube tip reaching the base of the stomach. A negative pressure is applied to empty the stomach of recently ingested materials and fluid. The advantage in removing particulate material and fluid can speed airway management and reduce the risk or minimize the complications from aspiration (Vandenberg et al, 1998).

2.3.2 Antacids

Antacids are of two types – particulate and non-particulate antacid. The use of antacids is now being restricted to non-particulate sub-type such as sodium citrate. Particulate antacids such as those containing magnesium or aluminium are likely to be associated with more severe pneumonitis should aspiration occur (Eyler et al 1982; Gibbs et al 1979).

2.3.3 Sodium citrate

Sodium citrate is the most effective agent for immediate neutralization of acidic gastric contents (Gibbs et al 1982). A 0.3 mol/l (8.8%) in a volume of 30 ml has pH of 8.4 and causes mean pH to increase to more than 6 for one hour. Molar solution of sodium citrate has been found to be equally effective in emergency and elective cases and with either general or regional anesthesia (Lin et al 1996, Stuart et al 1996). A rebound decrease in gastric pH below 2.5 can occur therefore sodium citrate 0.3 mol/l is recommended as a regular 2-4 hourly regimen for women in labor (Robert & Shirley, 1976).

2.3.4 H_2 receptor antagonists

The H_2 antagonists are competitive antagonists of histamine at the parietal cell H_2 receptor decreasing the production of acid by these cells. In this group agents include cimetidine, ranitidine, and famotidine. They suppress the normal secretion of acid by parietal cells and the meal-stimulated secretion of acid. They accomplish this by two mechanisms: Histamine released by enterochromaffin-like cells in the stomach is blocked from binding on parietal cell H_2 receptors, which stimulate acid secretion; therefore, other substances that promote acid secretion (such as gastrin and acetylcholine) have a reduced effect on parietal cells when the H_2 receptors are blocked.

One of the commonest H2 receptor antagonists in use is ranitidine. It is a histamine H_2-receptor antagonist that inhibits stomach acid production. It is commonly used in treatment of peptic ulcer disease (PUD) and gastro esophageal reflux disease (GERD). It has been demonstrated that 150 mg of oral ranitidine when given two to three hours before surgery resulted in a mean gastric pH of 5.86 within 60 minutes (Escolano 1996). It has also been shown that there is no significant difference between 150 mg and 300 mg, with both taking around 60 minutes to achieve a sustained increase in pH which then lasts for approximately five hours. When used in obstetric patients, these effects may be less predictable particularly in the context of active labor or concurrent opioid use (Murphy et al 1984,), or in the presence of particulate material in the stomach of non-fasted patients (Rout et al 1993), or with emergency as compared to elective surgery (Lim & Elegbe 1992).

The intravenous ranitidine have a faster rate of onset. An intravenous route of administration of 50 mg ranitidine during elective or emergent cesarean section achieves a gastric pH >2.5 and volume <25 ml within 45 minutes (Tripathi et al 1995).

2.3.5 Prokinetics

Prokinetics include the drugs, domperidone, metoclopramide and cisapride. Prokinetics claim to restore gastric motility and to increase the tone in the lower esophageal sphincter by enhancing acetylcholine release in the group of nerves that control upper gastrointestinal motility. These actions are said to speed up gastric emptying and reduce reflux into the esophagus. Metoclopramide, the most frequently used increases the rate of gastric emptying, has an antiemetic and increases lower esophageal sphincter tone. It has been shown that in combination with other agents in obstetric patients at a dose of 10 mg intravenous (Stuart et al 1996)

2.3.6 Proton Pump Inhibitors

Proton pump inhibitors (PPIs) are a group of drugs whose main action is a pronounced and long-lasting reduction of gastric acid production. PPIs act by irreversibly blocking the hydrogen/potassium adenosine triphosphatase enzyme system (the H +/K+ ATPase or more common gastric proton pump) of the gastric parietal cells. The proton pump is the terminal stage in gastric acid secretion, being directly responsible for secreting H^+ ions into the gastric lumen, making it an ideal target for inhibiting acid secretion.

Omeprazole has been the agent most extensively studied amongst PPIs. It can be given orally or by intravenous injection and has been studied at doses of 40 mg and 80 mg. The onset of effect after IV administration is similar to that of ranitidine and should be considered to be at least 40 minutes (Tripathi et al 1995). In the setting of emergency Cesarean section, a single intravenous dose of omeprazole 40 mg results in the same percentage of patients with the combination of pH <2.5 and volume > 25 ml as ranitidine 50 mg IV when combined with sodium citrate (Tripathi et al 1995, Stuart et al 1996,).

3. Immediate preanesthetic preparation

Following proper preoperative evaluation, consent for anesthesia and surgery obtained and possible premedicant administered, and the parturient is transferred to the operating theatre while maintaining a 15-20^{o} lateral uterine displacement (to prevent aorto-caval compression). Maternal hypotension from caval compression is a common problem during Cesarean section under anesthesia more so during spinal anesthesia. The possible explanation for this is combined aorto-caval compression by gravid uterus in parturient in addition to reduced systemic vascular resistance by spinal anesthesia. It was first reported in 1952 as "supine hypotension in late pregnancy" (Howard et al). This describes the hypotension which occurs in parturients upon assuming the supine position, and resolves with lateral positioning.

Some factors such as late pregnancy, the supine, and to a lesser extent, the sitting position, and more frequently in those with varicose veins have associated with this grave state. This form of hypotension occurs following compression of the inferior vena cava (IVC) by the gravid uterus with a consequent reduction in venous return. About five minutes are generally required for significant hypotension to become manifest (Howard et al 1953). Supine hypotension is most severe in non-laboring patients undergoing Cesarean section than those who are laboring (Brizgys et al, 1987). Supine hypotension is cured by delivery.

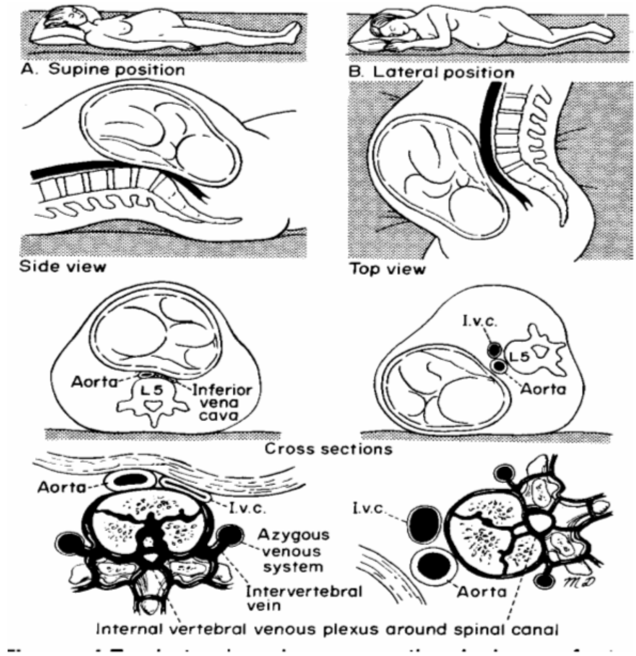

Fig. 2. Position of Gravid uterus on Inferior Vena Cava

Two compensatory mechanisms have been described for reducing the degree of hypotension which occurs as a result of impairment of venous return. Firstly, there may be a generalized increase in sympathetic tone and, secondly, the internal vertebral venous plexus and the azygos vein can act as a collateral conduit for blood returning from the lower part of the body. It was subsequently recognized that aortic compression could be as important as caval compression in the generation of decreased utero-placetal perfusion and fetal distress.

Maternal hypotension as measured by a reduction in brachial artery blood pressure occurs as a result of a reduction in venous return. It is most pronounced in hypovolemic states, either actual, as occurs with hemorrhage, or relative, as occurs following sympathetic blockade. Acute fetal distress can be caused by:

- hypoperfusion of the uteroplacental unit secondary to maternal hypotension, or
- occult aortic compression (in the presence of a normal maternal brachial arterial blood pressure) causing a reduction in iliac arterial flow.

Full left or right lateral position completely relieves aorto-caval compression. Elevating the mother's right hip 10-15cm completely relieves aorto-caval compression in 58% of term parturients (Kinsella et al, 1990). Lateral uterine displacement therefore, remains an all important technique in the prevention of supine hypotension and in the management of hypotension in all women during pregnancy.

4. Modes of anesthesia for cesarean section

General goals in choosing anesthesia are:

- the safety of the mother
- the safety of the baby
- the comfort of the mother
- the ability to perform the surgery under that anesthetic technique.

There are two general categories of anesthesia for Cesarean section - general anesthesia and regional anesthesia. Regional anesthesia includes both spinal and epidural techniques. General anesthesia is usually reserved for patients that must have anesthesia "right away" because their surgery is being done for a true emergency. In these situations, regional techniques may take too long to perform. It is also performed when contraindications for regional anesthesia are present.

However, there are some risks associated with general anesthesia that can be avoided with regional anesthesia. Therefore, regional anesthesia is almost universally preferred when time is not as much of a factor. Internationally, obstetric anesthesia guidelines recommend spinal and epidural over general anesthesia (GA) for most Cesarean sections (Cyna & Dodd, 2007). The primary reason for recommending regional blocks is the risk of failed tracheal intubation and aspiration of gastric contents in pregnant women who undergo GA (Bloom et al, 2005). While there is evidence that GA is associated with an increased need for neonatal resuscitation (Gordon et al, 2005), evidence about specific delivery indications and about neonatal outcomes subsequent to resuscitation is limited.

4.1 Regional anesthesia for cesarean section

Obstetric anesthesia has evolved substantially in the last two decades, with regional techniques becoming increasingly popular for Cesarean section. The method of choice may be a spinal, an epidural or a combination of the two (combined spinal epidural anesthesia). Spinal anesthesia has evolved as the preferred anesthetic technique for most cases of Cesarean section.

Although regional anesthesia has several advantages such as preservation of consciousness, avoidance of neonatal depression that occurs with general anesthesia, and avoidance of airway manipulation, it is contraindicated in conditions of hypovolemia, coagulopathies, infection at the site of injection and when the patient rejects the procedure. Some complications have been associated hypotension, post dural puncture headache (if spinal anesthesia is used) local anesthetic toxicity (involving central nervous system, cardiovascular system), high spinal, total spinal anesthesia (if inadvertent injection occurs during epidural injection), bradycardia and failed block.

4.2 Preparation for regional anesthesia

The administrator of the regional anesthetic should be aware of the potential complications associated with this technique and also be knowledgeable to manage them. Complications such as hypotension, respiratory arrest following excessive cephalad spread, seizures from central nervous system toxicity, cardiovascular collapse could occur. Therefore, the anesthetic machine should be checked and made ready, tracheal tubes of appropriate sizes, laryngoscope with appropriate blade sizes, suction machine, monitoring equipment, vasopressor agent like ephedrine, drugs for possible conversion to general anesthesia be made available for possible use and oxygen source.

Neuraxial block can impair respiratory function by paralysis of the intercostals muscles due to a high block. A satisfactory regional anesthesia for Cesarean delivery requires a block level to at least the T5 dermatome and this can alter respiratory performance (Kelly et al, 1996). Therefore, many anesthetists will administer supplementary oxygen to mothers undergoing regional anesthesia for Cesarean section to obviate the effect of an excessive cephalad spread of the local anesthetic. It has been found that administering supplemental oxygen during emergency Cesarean section increases fetal oxygenation without increasing lipid peroxidation in both the compromised and uncompromised fetuses (Khaw et al, 2002; Ogunbiyi et al, 2003),

4.3 Spinal anesthesia

Spinal anesthesia also called spinal analgesia or sub-arachnoid block (SAB), is a form of regional anesthesia involving injection of a local anesthetic agent into the subarachnoid space, generally through a fine needle, usually 9 cm long (3.5 inches). For extremely obese patients, some anesthesiologists prefer spinal needles which are 12.7 cm long (5 inches). The tip of the spinal needle has a point or small bevel. Recently, pencil point needles have been made available (Hart & Whitacre, 1951; Sprotte et al, 1987). Regardless of the anesthetic agent (drug) used, the desired effect is to block the transmission of afferent nerve signals from peripheral nociceptors. Sensory signals from the site are blocked, thereby eliminating pain. The degree of neuronal blockade depends on the amount and concentration of local anesthetic used and the properties of the axon. Thin unmylenated C-fibres associated with pain are blocked first, while thick, heavily mylenated A-alpha motor neurons are blocked last. The desired result is total numbness of the area. A pressure sensation is permissible and often occurs due to incomplete blockade of the thicker A-beta mechanoreceptors. This allows surgical procedures to be performed with no painful sensation to the person undergoing the procedure.

Spinal anesthesia for Cesarean section is gradually gaining popularity and substituting the general anesthesia. The use of spinal anesthesia for Cesarean delivery was facilitated by the popularization of pencil-point needles, which dramatically reduced the incidence of postdural puncture headache.

The International goal for protection of future mothers is 80-90% of all Cesarean section to be carried out under spinal anesthesia. This is a simple and reliable regional anesthetic technique that provides a high quality sensory and motor blockade immediately following the subarachnoid administration of the local anesthetic agent (Gogarten & Van Aken, 2005). It offers some advantages over general anesthesia in many ways such as minimal exposure of fetus to medications, parturient remaining conscious throughout the anesthesia and surgery. The preservation of airway protective reflexes becomes a desirable quality in abolishing the risk of aspiration.

Maternal hypotension is one of the commonest challenges that may accompany spinal anesthesia for Cesarean section. The incidence of hypotension could be as high as 80% (Rout & Rocke, 1994) and it could compromise the wellbeing of both mother and fetus (Vorke et al, 1982). Hypotension following spinal anesthesia for Cesarean section may be associated with associated symptoms such as nausea and vomiting which still persist, despite many efforts to improve their treatment and prevention. Rapid administration of crystalloid solutions before spinal anesthesia has been recommended by many anesthesiologists to prevent hypotension (Clark et al, 1976)). Although controversy still exists, there is accumulating evidence that crystalloid solutions are particularly ineffective in preventing hypotension after extensive sympathetic blockade associated with spinal anesthesia (Jackson et al, 1995).

Preloading is routinely carried before the institution of neuraxial block. About 500 – 1000 ml of fluid (10-15 ml/kg crystalloid over 20 minutes) or colloid (such as 6% hydroxyethyl starch, 4% succinylated gelatin (Turker et al, 2011)) is used. Crystalloid rapidly moves into the interstitial space and therefore, the increase in central blood volume garnered from an intravenous bolus of crystalloid (no matter how much) is fleeting. Colloids remain within the intravascular space for a prolonged period, therefore, are more effective at both increasing cardiac output and reducing the incidence of hypotension. Unfortunately, colloids are less available, more expensive and have a low risk of severe allergic reaction. One method that has shown promise is to delay the preload until after the spinal block or concomitant to induction of the spinal anesthetic (co-hydration or co-load). One study which compared preload and co-load using lactated ringer found that cardiac output remained elevated above baseline for 30 min after induction of anesthesia in the co-load group (Kamenik & Payer-Erzen, 2001). Another study also showed that rapid crystalloid infusion during or at the time of spinal induction was more effective at preventing hypotension than a preload of the same volume of crystalloid prior to Cesarean section (Dryer et al, 2004).

Most spinal anesthetics are conducted with the parturient on the operating table in order to reduce tendency of multiple patient transfers from one trolley/bed to the other. It is of the essence to ensure asepsis during the performance of the procedure, equipment check, intravenous fluids, and source of oxygen and means of delivering it, monitors to check blood pressure, oximetry, electrocardiogram and the availability of vasopressor. In addition, the anesthetic machine must be prepared and cart should have tracheal tubes of appropriate sizes, laryngoscopes and drugs for possible administration of general anesthesia.

Proper positioning is essential for a successful conduction of spinal anesthesia. This is often done either while the patient is in sitting or the lateral position. In the lateral, the patient is positioned with their back parallel with the side of the operating table. Thighs are flexed up, and neck is flexed forward (see Fig. 3a) Patient should be positioned to take advantage of the baricity of the spinal local anesthetic.

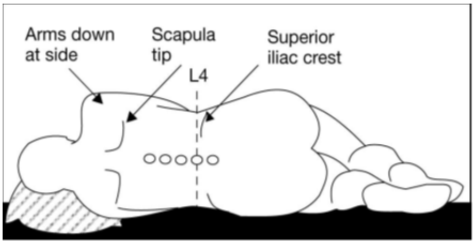

Fig. 3a. Lateral position for spinal block

In the sitting position, the patient's feet are placed on a stool while she sits up straight, her head flexed, arms hugging a pillow (see Fig. 3b).

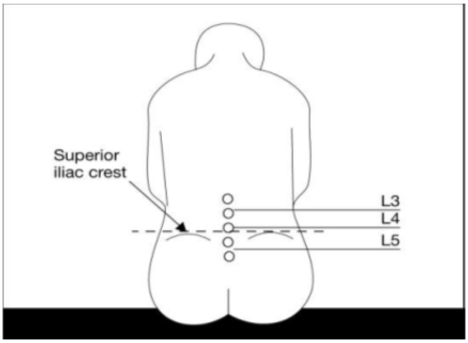

Fig. 3b. Sitting position for spinal block

In the administration of the local anesthetic for subarachnoid block, the size and type of needle are of vital importance. The most frequently used needle is the pencil tip. The Quincke needle inflicts more damage to the dural sheath at the point of entry and leads to post-dural puncture headache. Following aseptic protocols, the predetermined dose of the local anesthetic for the subarachnoid injection is drawn up and tagged. Also drawn up is the local anesthetic to be used for skin infiltration into the 2ml syringe. The patient is positioned and the back cleaned with antiseptic. The interspinous space is located after draping of the back of the parturient. A skin wheal of local anesthetic is raised at the intended interspinous space. An introducer is inserted as 25 gauge needles are often used. The introducer is advanced into the ligamentum flavum while avoiding accidental dural puncture. The 25 gauge spinal needle is then passed through the introducer with the bevel directed laterally (if Quincke tip needle is used). While advancing the needle, an increased resistance is felt as the needle enters the ligamentum flavum, followed by a loss of resistance as the epidural space is entered. Another loss of resistance is usually felt as the dura is pierced and CSF back flow occurs through the needle when the stylet is removed.

The local anesthetic is injected through the needle as soon as the stylet is removed. The spinal needle, introducer and syringe are withdrawn as one immediately after the injection is complete, and a sticking plaster is applied to the puncture site. The parturient is quickly returned supine while ensuring left lateral uterine displacement to avoid aorto-caval compression. It is important to assess the height of the block before commencement of any surgical stimulation. It is unnecessary to test sensation with a sharp needle and leave the patient with a series of bleeding puncture wounds. It is better to test for a loss of temperature sensation using a swab soaked in alcohol.

The addition of opioids to local anesthetics has been widely used in clinical practice for over 30 years; however, the efficacy and safety of this method are still in dispute. It is a common practice to use 2.0 – 2.5 ml hyperbaric bupivacaine 0.5% alone or in combination with opioid to improve the quality of the block without producing a higher level of analgesia to pinprick (Russell, 1995) and, provide some postoperative analgesia. In order to limit the adverse effects, local anesthetic agents are combined with low doses of opioids. Administered subarachnoidally, they reduce the dose of bupivacaine; improve the quality of intraoperative analgesia and their analgesic effects last in the postoperative period (Hamber & Viscomi, 1999; Chung et al, 2002).

Some anesthesiologists prefer lipophilic opioids highlighting their quick onset of action (intraoperative), analgesic effects in the early postoperative period (6 h) and minor adverse side effects (Hunt et al, 1989). Fentanyl is recommended in the dose of 20-30 µg (Hamber & Viscomi, 1999). In the case of morphine, 50 µg does not provide analgesic effects while the dose of 200 µg induces too strong adverse effects (pruritus, nausea and vomiting) and symptoms of late respiratory depression (Milner et al, 1996).

All agents injected into the subarachnoid space must be preservative-free solution. The height of block appropriate for Cesarean section is T6 bilaterally. Hypotension is very common following spinal anesthesia for Cesarean section. The extensive pharmacologic sympathectomy causes arteriolar dilatation, venodilatation and suppression of the ionotropy and chronotropy of the heart. This in combination with the aorto-caval compression leads rapidly to hypotension, bradycardia and low cardiac output. Arterial hypotension is a dangerous complication for both the parturient and the fetus. The hypotension manifests with clinical signs on the parturients side as nausea, vomiting and yawning. The long-lasting profound hypotension causes fetal acidosis and neonatal depression.

In clinical practice, the hypotension is treated promptly with vasopressors such as ephedrine and phenylephrine in boluses or as infusion. Ephedrine, most frequently used, is a directly acting beta-1 and indirectly acting alpha-1 adrenergic agonist. One part of its vasoconstricting capacity is as a result of elevated production of angiotensin-2. Ephedrine is administered in boluses of 3-5 mg while phenylephrine is given as 0.05-0.1 mg blouses. Monitoring of the patient under anesthesia and surgery cannot be over-emphasized. During the intraoperative period, pain or discomfort could arise. In such cases, a mixture of 50% oxygen in nitrous oxide could be administered along with intravenous opioid like low doses of fentanyl.

Following the delivery of the baby, 5-10 units of oxytocin are normally administered to aid myometrial contraction. Routine postoperative procedures are carried out at the end of the anesthesia and surgery.

4.4 Epidural anesthesia

This is a form of regional analgesia involving injection of drugs through a catheter placed into the epidural space. The injection can cause both a loss of sensation (anesthesia) and a loss of pain (analgesia), by blocking the transmission of signals through nerves in or near the spinal cord.

Epidural anesthesia is a form of neuraxial block technique for Cesarean section. Its use in humans was first described in 1921 (Pages, 1921). Later, the Tuohy needle which is still most commonly used for epidural anesthesia was introduced (Tuohy, 1937). Improvements in equipment, drugs and technique have made it a popular and versatile anesthetic technique, with applications in obstetrics and pain control. Both single injection and catheter techniques can be used. Its versatility means it can be used as an anesthetic, as an analgesic adjuvant to general anesthesia, and for postoperative analgesia following Cesarean section.

Epidural anesthesia can be used as the sole anesthetic for labor and Cesarean section. The advantage of epidural over spinal anesthesia is the ability to maintain continuous anesthesia after placement of an epidural catheter, thus making it suitable for procedures of long duration such as labor and delivery. This feature also enables the use of this technique into the postoperative period for analgesia, using lower concentrations of local anesthetic drugs or in combination with different agents.

The disadvantages of epidural anesthesia are that the onset of the block takes a longer time than spinal anesthesia and the spread of block could be uneven, often resulting to poor anesthesia of the sacral roots. Cardiovascular stability is one of its advantages implying that this technique could be tolerated by parturients with cardiac diseases. Following the insertion of the epidural catheter, the duration of anesthesia/analgesia can be prolonged from repeated top-ups with local anesthetic agents or a combination of such agents and opioids.

4.4.1 Technique of epidural anesthesia

The standard procedure for the administration of epidural anesthesia is essentially the same for subarachnoid block. Asepsis must be maintained throughout the procedure.

Following the cleaning draping of the parturients' back, a subcutaneous wheal at the midpoint (at the planned puncture site) between two adjacent vertebrae is raised using a local anesthetic. This area is infiltrated deeper in the midline and paraspinously to anesthetize the posterior structures. A puncture at the site is done using a 19G needle. The epidural needle is inserted in to the skin at this point, and advanced through the supraspinous ligament, with the needle pointing in a slightly cephalad direction. It is then advanced into the interspinous ligament until distinct sensation of increased resistance is felt as the needle passes into the ligamentum flavum.

The end point of the procedure is the loss of resistance to either air or fluid (saline or local anesthetic). Other methods of identifying the epidural space include the use of Epidural balloon (Fyneface-Ogan & Mato, 2008), Episure syringe (Riley & Carvalho, 2007) and the Bi-digital pressure method (Carden & Ori, 2006). Occasionally, false loss of resistance may cause some difficulty with placing an epidural. Once the needle enters the ligamentum flavum, there is usually a distinctive sensation of increased resistance, as this is a dense ligament with a leathery consistency.

The agents and doses used for epidural anesthesia for Cesarean section include

- Bupivacaine 0.5% 15-20 ml with 1 in 200, 000 epinephrine
- Lidocaine 2% 15-20 ml with 1 in 200, 000 epinephrine
- Fentanyl 50 microgram or diamorphine 2.5 mg may be added to the local anesthetic to improve the quality of anesthesia.

4.5 Combined spinal epidural anesthesia

The combined spinal-epidural (CSE) technique has gained increasing popularity for patients undergoing major surgery below the umbilical level who require prolonged and effective postoperative analgesia. Although the CSE technique has become increasingly popular over the past two decades, it is a more complex technique that requires comprehensive understanding of epidural and spinal physiology and pharmacology. It combines the rapidity, density, and reliability of a subarachnoid anesthetic with the flexibility of continuous epidural anesthesia to extend the duration of analgesia (Rawal et al, 2000). The technique is particularly popular in obstetric anesthesia and analgesia. A modification of the conventional CSE is the sequential CSE technique, in which spinal anesthesia is induced with a small-dose intrathecal local anesthetic and opioids to produce a limited anesthetic that can be extended with epidural top-ups of local anesthetic or saline. This epidural volume extension (EVE) may be due to several mechanisms including the ‘volume effect’ in which the dura is compressed by epidural saline, resulting in ‘squeezing’ of cerebrospinal fluid and more extensive spread of subarachnoidal local anesthetic (Lew et al, 2004). The volume effect appears to be time-dependent; beyond 30 min or after two-segment regression has begun, any epidural top-up of saline would have no effect on block extension and may even accelerate regression of the spinal anesthetic.

There are four main varieties of combined spinal epidural anesthesia. These are:

- Single Needle - Single Interspace method
- Double Needle - Double Interspace method
- Double Needle - Single Interspace method
- Needle Beside Needle - single interspace method

The detailed description of these techniques is beyond the scope of this chapter. It is important to note that the “needle through needle” technique is the most popular variety of CSE techniques (Cousins MJ, 1988). This results in high success rates and obviates a separate second needle placement in the majority of cases, minimizing patient discomfort. It is also simple and quick, requiring approximately 30 seconds longer than the time needed for routine lumbar epidural catheter placement. Technical performance of this technique is improved when properly matched epidural and spinal needles are used. The reason for its popularity is the ability of extra-dural needle to guide the fine spinal needle to the dura mater. In addition, patients prefer a single skin puncture (Lyons et al, 1992).

In the CSE technique, the subarachnoid block is performed using the same dose of local anesthetic described for spinal anesthesia. The epidural catheter is placed to allow top-ups of local anesthetics during prolonged surgery or for the administration of analgesic in the postoperative period.

Combined spinal epidural anesthesia especially in elective Cesarean section, which affords time to perfect the analgesia with the epidural if necessary, provide exceptional standards of analgesia. There is no standard CSE or epidural technique. Compared with epidural, CSE provides faster onset of effective pain relief from time of injection, and increases incidence of maternal satisfaction (Hughes et al, 2003). Combined spinal epidural anesthesia appears to be safe as an anesthetic technique for severe pre-eclampsia/eclampsia (Vande Velde, 2004).

4.6 Local infiltrative anesthesia

Local infiltrative anesthesia is not a common technique of anesthesia for Cesarean section. This form of anesthesia is often practiced in poor resource settings. It is frequently carried out by the surgeon. The use of local infiltrative anesthesia has been used in very poor clinical state such as eclampsia (Fyneface-Ogan & Uzoigwe, 2008). It is safe and is beneficial for the mother and child in the following ways:

- Can be a life saving procedure
- Recovering time is less
- None or very little side effects
- Economical (for both mother & Government)
- Post operative care is relatively easy
- Fetus will be in a good condition
- Makes surgical intervention easily available, accessible and affordable.

A hand on experience is essential. It is contraindicated in the following:

- Two previous Cesarean sections
- Associated adnexial pathology
- Obese patient
- Placenta previa
- Apprehensive cases

5. General anesthesia for cesarean section

The use of general anesthesia for Cesarean section is declining world-wide. Although there are few, if any, absolute contraindications to general anesthesia, regional anesthesia appears to be the preferred method in order to avoid the risk of airway challenges. As early bonding immediately after delivery is being encouraged, increasingly parturients are choosing to remain awake to witness the birth of their babies. General anesthesia requires the production of unconsciousness, provision of adequate analgesia and muscle relaxation. The administration of this form of anesthesia offers some advantages such as uterine relaxation for extracting difficult breech presentation, removing retained placentas and conduct utero-fetal surgeries. Other advantages of this form of anesthesia include rapid induction, less hypotension (appropriate in settings of acute maternal hypovolemic state), better cardiovascular stability, better control of the parturient’s airway, and found to be useful in patients with coagulopathies, pre-existing neurologic or lumbar disc disease or infections.

A detailed preoperative evaluation cannot be over-emphasized if general anesthesia will be used for Cesarean section. The leading causes of maternal mortality such as failed tracheal intubation, failed ventilation and oxygenation, and/or pulmonary aspiration of gastric contents are linked to poor airway management (Ross BK, 2003). Therefore anticipation of a difficult tracheal intubation may reduce the incidence of failed intubations. A thorough examination of the neck, mandible, dentition, and oropharynx often helps predict which patients may have such problems. Difficult airway predictors found to be useful include Mallampati classification, short neck, receding mandible, and prominent maxillary incisors. It has been shown that higher incidence of failed intubation is more amongst parturients than the non-pregnant women. This is frequently attributed to airway edema, full dentition, and large breasts can obstruct the handle of the laryngoscope in pregnant women with short neck.

5.1 Failed intubation drill

Airway evaluation is not perfect and problems may arise even if the patient is evaluated as not presenting airway difficulties. Failed intubation occurs more in the pregnant population (*vide supra*). If it occurs, management is geared towards maintaining oxygenation and preventing aspiration of gastric contents. The failed intubation drill is a guideline that represents the default strategy for tracheal intubation when this is not predicted to be difficult. This strategy must cope with the unexpected difficult direct laryngoscopy. It is widely practiced for Cesarean section under general anesthesia.

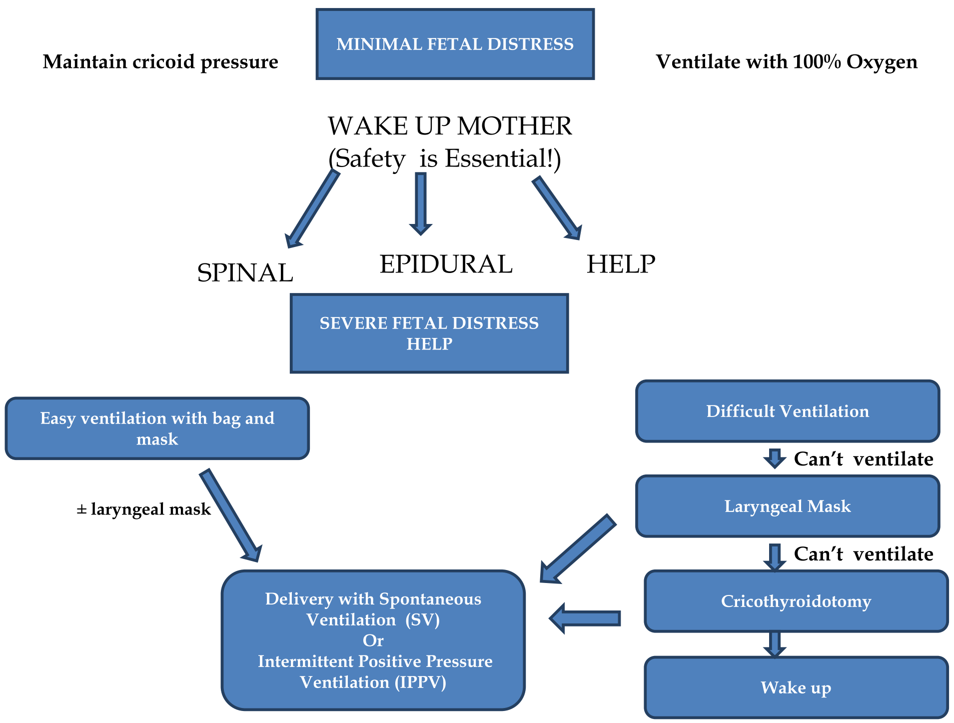

Fig. 4. Failed Intubation Guidelines

Early recognition of failure is of vital importance and assistance sought immediately while maintaining the cricoids pressure. During the failed intubation drill, the left lateral uterine displacement should be ensured. Oxygenation of the patient should continue through the face mask using 100% oxygen by an assistant squeezing the reservoir bag if both hands are needed to stabilize the mask. If the Cesarean section is an elective, the patient is allowed to wake up and alternative technique planned. Such intended general anesthesia can be converted into regional technique. In emergency, the surgery may continue with mask ventilation and application of cricoids pressure throughout the duration. In this situation, the patient's stomach must be emptied using a wide bore tube while maintaining a left lateral displacement of the uterus. The surgical field can also be infiltrated with local anesthetic to reduce the need for volatile anesthetic. However, should ventilation by face mask, laryngeal mask airway or any other device fails, cricothyrotomy is performed immediately and the patient made to wake up. The use of fibreoptic bronchoscope is gaining attention following failed tracheal intubation in the airway management of obese pregnant women undergoing Cesarean section (Dhonneur et al, 2007). However, this has not been extensively studied in the pregnant population.

5.2 Anesthetic management

Following proper preoperative assessment, the conduction of general anesthesia for Cesarean section commences with administration of non-particulate antacid within an hour of induction. An intravenous ranitidine 150 mg or 30 ml 0.3M sodium citrate is administered. A wide-bore intravenous canula (preferably, size 16 G or 18 G) is placed for intravenous fluid administration. The patient is placed supine with a wedge under the right hip for left uterine displacement. Preoxygenation is commenced with 100% oxygen for about 5 minutes while monitors are applied. The parturient is prepared and draped for surgery. Before the commencement of surgery, a rapid sequence induction with cricoid pressure applied and maintained (by an assistant until position of the tracheal tube is verified and cuff inflated) using thiopental 4-6 mg/kg (propofol 2 mg/kg) or ketamine 1.5 mg/kg (if patient is asthmatic) and suxamethonium 1.5 mg/kg. Surgery commences after tube placement is confirmed by capnography. Fifty percent nitrous oxide in oxygen with low dose halothane (0.5%) or 1% sevoflurane or 0.75% isoflurane or 3% desflurane is used for maintenance. These low doses of the halogenated agents do not produce excessive uterine relaxation but play a significant role in ensuring amnesia during anesthesia and surgery. Intermediate acting muscle relaxant such as atracurium, mivacurium, rocuronium or cis-atracurium is required to maintain muscle relaxation.

Excessive ventilation during anesthesia should be avoided. Maternal hyperventilation (arterial carbon dioxide pressure < 20 mm Hg) during general anesthesia may be harmful to the unborn fetus. Uterine blood flow is reduced during the institution of positive-pressure ventilation, and hyperventilation causes a leftward shift in the maternal oxygen-hemoglobin dissociation curve and decreases oxygen availability to the fetus (Levinson et al, 1974). Hypocarbia may also cause decreased umbilical blood flow from vasoconstriction (Motoyama et al, 1966).

Following the delivery of the baby and the placenta, 20 units of oxytocin is added into each litre of intravenous fluid and titrated slowly. Oxytocin should be used with caution as it has been associated with severe hypotension and tachycardia (Hendricks & Brenner, 1970).

Although the exact mechanism is unknown, the preservative, chlorobutanol, has been suggested as the cause of these hemodynamic changes (Rosaeg & Cicutti, 1998). The nitrous concentration may then be increased to 70% and an opioid may also be given to augment the analgesic effect of the nitrous and also to ensure amnesia. Methylergonovine 0.2 mg may be administered intramuscularly should the uterus fail to contract. Poor uterine contraction may lead more blood loss during surgery. Prior to the end of the surgery the gastric content is aspirated via oro-gastric tube to reduce the tendency for pulmonary aspiration during emergence from anesthesia.

5.3 Reversal and recovery

At the end of the surgery, the effect of the muscle relaxant is reversed and the oro-gastric tube removed. The hypopharynx is suctioned dry and trachea is extubated when patient is fully awake to prevent the risk of regurgitation and aspiration (Asai et al, 1998).

6. Anesthesia for emergency cesarean section

Emergency Cesarean section is done to avert potential loss of life of the mother, newborn or both. Good multidisciplinary communication is pivotal in the management of an emergency Cesarean section for good feto-maternal outcome. A four-point classification (see Table 1a below) of urgency of Cesarean section, similar to that used by the National Confidential Enquiry into Perioperative Deaths, has been validated and accepted by anesthetists and obstetricians based on theoretical and actual scenarios (Lucas et al, 2000). Categories 1 and 2 are considered as emergency Cesarean section is while Category 3 case (e.g. a woman who has booked for an elective Cesarean section but goes into labor ahead of her scheduled operation date) is no longer elective, but neither is this a true ‘emergency’ scenario.

Grade	Definition (at time of decision to operate)
Category 1	Immediate threat to life of woman or fetus
Category 2	Maternal or fetal compromise, not immediately life-threatening
Category 3	Needing early delivery but no maternal or fetal compromise
Category 4	At a time to suit the woman and maternity team

(Lucas et al, 2000)

Table 1a. Categorization of urgency of Cesarean Section

Anesthesia for emergency Cesarean section can pose many challenges to the attending anesthetist. One of the greatest challenges for an unprepared attending is to be compelled to administer general anesthesia under less than ideal conditions to an unfasted parturient. This predicament can often be avoided if anesthetist is informed earlier about the existence of such ‘high-risk’ cases before the rapid deterioration of the maternal–fetal clinical state and the decision for Cesarean section is finally made. This would serve to enhance the preparedness of the attending and operating theatre staff in the eventuality of Cesarean section.

Most often, emergency Cesarean section is carried out on account of a deteriorating fetal or maternal clinical state. Table 1b, shows some feto-maternal indications that require or may require emergency Cesarean section.

Fetal scalp pH <7.20
Category III fetal heart rate tracings (Macones et al, 2008)
Cord prolapsed
Uterine rupture
Cepahlo-pelvic disproportion diagnosed during labor
Pre-eclampsia/eclampsia
Antepartum hemorrhage
Failure of labour to progress

Table 1b. Feto-Maternal Indications

Being a complex multidisciplinary procedure, it has been recommended that Caesarean section should be ready to be performed within 30 minutes of decision-to-operate is made. It has been suggested that most of the emergency Cesarean sections can be performed under regional anesthesia (Royal College of Anaesthetists, 2006). For the parturient with epidural catheter in labor, the anesthetic technique of choice will be to top-up the epidural. If this is contra-indicated, a single shot spinal anesthesia will be appropriate for most of the women laboring without labor epidural catheter. Whether the top-up should be administered in delivery room or theatre is controversial (Moore & Russell, 2004) Topping-up in the delivery room might gain time, but maternal monitoring is suboptimal when the risk of high block or systemic local anesthetic toxicity is greatest. Waiting until arrival in theatre before starting to top-up can invoke obstetrician impatience and a call for general anesthesia. A compromise is to administer a small initial dose in the delivery room (e.g. 10 ml plain bupivacaine 0.5%) and further 5-ml increments as required in theatre.

Single-shot spinal anesthesia can be administered to laboring women without epidural catheter. However, active bleeding, cardiac disease, uncorrected coagulopathy and a high suspicion of bacteremia are contraindications to single-shot spinal anesthesia. Most often hyperbaric bupivacaine 0.5%, 2 ml is appropriate for most women; the addition of fentanyl 20 µg enhances blockade of visceral pain. Preload (administration of fluid before spinal anesthesia) has been superseded by 'co-load' – a fluid bolus coinciding with the sympathetic blockade. Timing of the administration of vasopressors is important in the event of hypotension. Phenylephrine or ephedrine should be available for possible use. Reflex bradycardia (heart rate 45– 50 beat/min) is to be expected after an alpha-adrenergic agonist, and an anticholinergic agent (atropine) should be immediately available, although administration is rarely necessary.

The rapid sequence induction (using thiopental, succinylcholine, cricoid pressure, tracheal intubation) appears to be the safest approach to general anesthesia for emergency Cesarean section (Levy, 2006). The use of muscle relaxant and end-tidal vapor concentrations >0.75% in nitrous have been recommended. There is no justification for administration of low inspired vapor concentrations that risk awareness. In the event of severe hypovolemia, anesthesia can be induced and maintained with intravenous ketamine (1.5 mg/kg), which has a useful sympathomimetic effect.

In all the options of anesthesia for emergency Cesarean section, the need for adequate monitoring of the parturients, both intraoperative and postoperative analgesia and maintenance of proper fluid therapy cannot be over-emphasized. Fluid input and output must be charted meticulously. No study has shown that crystalloid or colloid is superior. Crystalloid infusion may reduce plasma colloid oncotic pressure, but the longer half-life of colloid infusions may contribute to circulatory overload during the period of postpartum mobilization of the increased extracellular fluid volume of pregnancy. In the event of a continued synthetic oxytocin after surgery, administration should be in small doses either by syringe pump or gravimetric method via an intravenous infusion. Blood transfusion should be carried out with caution. Administration of blood and blood products seems to be a risk factor for the development of pulmonary edema (Tuffnell et al, 2005).

The general approach to pain after Cesarean section is changing, shifting away from traditional opioid-based therapy toward a "multimodal" or "balanced" approach. Multimodal pain therapy involves the use of a potent opioid regimen, such as patient-controlled analgesia or neuraxial opioids, in combination with other classes of analgesic drugs. Theoretically, the use of analgesic drugs in combination allows for additive or even synergistic effects in reducing pain while decreasing the side effects produced by each class of drug because smaller drug doses are required. Typical analgesic regimens include opioids; non-opioid analgesics, such as acetaminophen; and non-steroidal anti-inflammatory drugs, with the variable addition of local anesthetic techniques. Despite current advances in postoperative pain therapy, pain relief may still be inadequate for a substantial number of women. This may be particularly true as they make the transition from relative dependency on potent opioid regimens to full dependency on oral analgesics on the second postoperative day (Angle & Walsh, 2001).

7. Conclusion

Anesthesia for Cesarean section continues to be one of the most commonly performed world-wide. Regional anesthesia has become the preferred technique for Cesarean delivery. Compared to general anesthesia, regional anesthesia is associated with reduced maternal mortality, the need for fewer drugs, and more direct experience of childbirth, faster neonatal-maternal bonding, decreased blood loss and excellent postoperative pain control through the use of neuraxial opioid. However, it is important to prevent aorto-caval compression and promptly treat hypotension during regional anesthesia for Cesarean section. The advantages of general over regional anesthesia are well known to include a more rapid induction, less hypotension, less maternal anxiety and its application in situations where there is a contraindication to regional anesthesia. Although literatures available indicate that both techniques are safe. Loss of airway control has been associated with severe morbidity and mortality during general anesthesia. The need for proper preoperative evaluation and airway assessment, the availability of an assistant, a backup plan for failed tracheal intubation, quick airway access and adequate oxygenation during general anesthesia for Cesarean section cannot be overemphasized.

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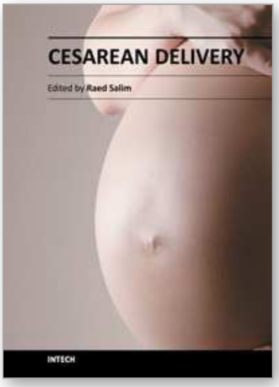

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This book provides broad, science-based information regarding the most common major surgical procedure performed, i.e. Cesarean Delivery. The book provides relevant scientific literature regarding epidemiology and rates of cesarean delivery in low and high income countries and the impact of the disparities in the rate of cesarean delivery between countries. In addition, the book systematically reviews the relevant scientific literature regarding all perioperative considerations with a broad cover of anesthetic techniques, drugs and difficulties that anesthesiologists may encounter during cesarean delivery. Care of the neonate after cesarean and crucial guidelines for obese women undergoing cesarean are also provided. The book was written by distinguished experts from different disciplines to ensure complete and accurate coverage of the recent scientific and clinical advances and to bring care providers and purchasers up to date including essential information to help improve health care quality.

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