

Research/Technical Note

Comparative Study of General Anesthesia and Regional Anesthesia in Obstetrics

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Abstract

Anaesthesia plays a major role in medical emergencies. In obstetric emergencies, general anaesthesia is preferred where rapid anesthesia is needed. Regional anaesthesia includes techniques like epidural, spinal, or combined spinal-epidural anesthesia and they produce loss of sensation without altering consciousness. The combined spinal-epidural improves epidural anesthesia quality during labor. Maternal mortality is a great concern worldwide. According to the World Health Organization, in the year 2020, 95% of maternal deaths occurred in low and lower-middle-income countries. Maternal mortality concern aims to reduce mortality rates. To reduce complication mentioned above, a primary literature survey of 34+ articles/papers has been performed to compare the implications of obstetrical anaesthesia, different anesthesia types and anaesthetic management. A comparative study based on the effective parameters like *anesthetic management*, *Apgar score*, *maternal/neonatal outcome*, *maternal complication*, *maternal mortality*, *obstetric emergencies*, and *anesthetic preference* has performed to assess the effect of general anaesthesia on maternal and neonatal outcomes, patient's safety, factors that affect anaesthetic management, identification and management of post-spinal hypotension in cesarean section, rapid assessment and management of obstetric and risk of failed intubation. The main contribution of the work is to summarize the outcomes to come up with significant observations which reveal that regional anaesthesia is a comparatively safe and common method of anaesthesia in non-emergent cases. The study also observed that the amalgamation of general anaesthesia with 'rapid-Sequence induction and intubation', and aspiration prophylaxis is the safest method of emergency management in cesarean section. The paper concludes that in non-emergent obstetric cases, regional anaesthesia is preferred over general anaesthesia, whereas the general anaesthesia is best option for emergent cases.

Keywords

Anaesthetic Management, Apgar Score, Caesarean Section, Emergency Caesarean, Maternal and Fetal Complications, Maternal Mortality, Neonatal Outcomes

1. Introduction

According to the World Health Organization (WHO), every day in 2020, almost 800 women died from preventable causes related to pregnancy and childbirth. Between 2000 and 2020,

the maternal mortality ratio, and number of maternal deaths per 100,000 live births dropped by about 34% worldwide. Almost 95% of all maternal deaths occurred in low and low-

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er-middle-income countries in 2020 [1]. Pregnancy-related physiological changes such as *Cardiovascular Changes*: Cardiac output increases by up to 50%, with an increase in Heart Rate (HR) (10-20 beats per minute) and stroke volume (30-40%). *Respiratory Changes*: In upper airways, venous engorgement, and laryngeal or pharyngeal edema with narrowing of airways. The Functional Residual Capacity (FRC) is reduced by 20% by term. The Minute ventilation (MV) is increased by 50%. *Haematological Changes*: (i) Plasma volume increases by about 40-50%. (ii) The Red Blood Cell (RBC) mass is increases by about 20-30%, but this increment is smaller relative to the plasma volume, leading to physiological anemia during pregnancy. *The Gastrointestinal Tract (GIT) changes*: Loss of lower esophageal sphincter muscle tone due to this it is common for parturients to have symptoms of acid reflux and regurgitation [2].

Obstetrics face severe postoperative pain challenges. Postoperative pain management remains a significant challenge in medicine and depends on opioids and RA. Neuraxial analgesia (gold standard) for labor pain relief with various techniques. On the other hand, Apgar is a quick test performed on a baby at 1 and 5 minutes after birth. The 1-minute score determines how well the baby tolerated the birthing process [3]. It is observed that there is a higher Apgar in Spinal Anesthesia (SA) than in GA. Maternal mortality concern due to haemorrhage aims to reduce MR. Reliable methods are needed for accurate blood loss estimation in obstetric haemorrhage. Multidisciplinary teamwork is vital to prevent maternal and fetal mortality. Rapid response protocols and active

management strategies are recommended for haemorrhage. Anaesthetists play a crucial role in managing antepartum haemorrhage for maternal safety [4]. Suppose we compare GA with SA for maternal and neonatal outcomes. It is concluded that GA is linked to more maternal blood loss and lower Apgar scores [5]. The Neonatal Intensive Care Unit (NICU) need was higher in GA. In epidural anesthesia, no negative outcome was found. The Post-dural Puncture Headache (PDPH) is a major complication of Neuraxial Anesthesia (NA). It is postural, and frontal and relieved when the patient is supine position. It can occur following spinal and epidural anesthesia [6]. Neonates delivered by CS are more prone to developing respiratory tract infections, obesity, and the manifestations of asthma than those delivered vaginally. The risk of developing diabetes mellitus type 1 or neurological disorders in offspring after CS is still under discussion [7]. SA for C-sections, addressing post-spinal hypotension and enhancing patient care. Identifying and managing post-spinal hypotension in Caesarean deliveries effectively can enhance patient care and safety through timely interventions. Vaso-pressors such as Phenylephrine are recommended for preventing and treating spinal hypotension in CS [8]. The Combined Spinal-epidural Anaesthesia (CSE) improves Epidural Analgesia (EA) quality during labor. Recent advancement reduces Maternal Mortality Rate (MMR). Practitioners should keep in mind all physiological changes related to pregnancy. Multidisciplinary teamwork is important to prevent maternal and fetal mortality.

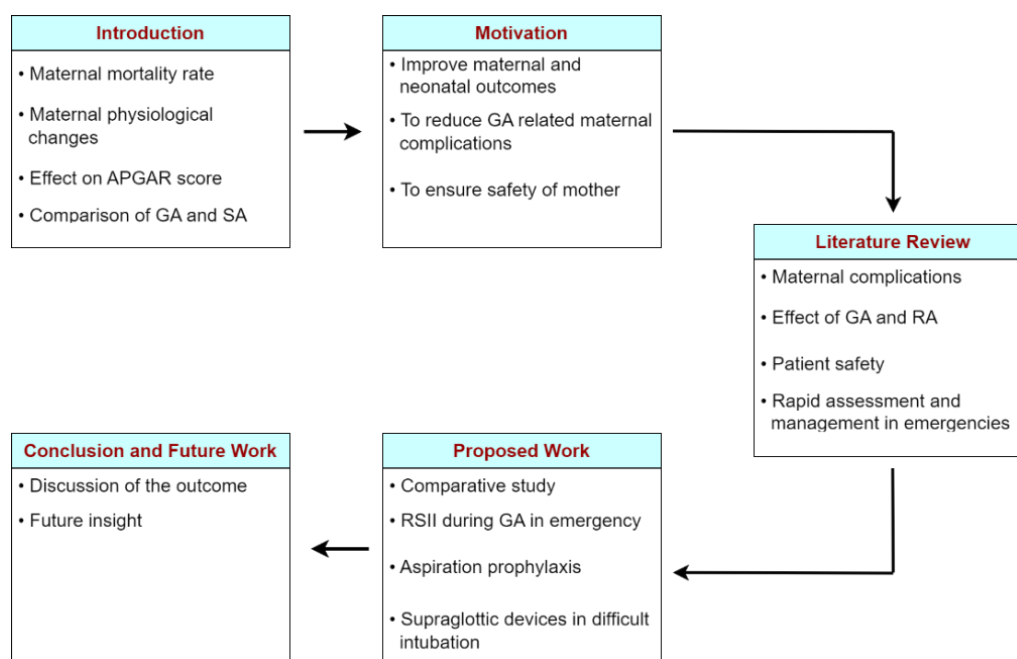


Figure 1. A complete roadmap of the presented work.

The subsequent sections of this paper are organized as follows: Besides the introduction, section 1 also explains the

preliminary Section 2 elaborates the literature review of 17 potential works in the concern domain and ends with a

graphical representation of a number of papers selected for a particular year. The summarized comparative study is explained in section 3 (refer to Table 1), while the result and discussion of the work are given in section 4. Section 5 concludes the work with some potential future scope. A complete roadmap of the paper is shown in Figure 1.

2. Literature Review

In 2018, Dongare, P. A. and Nataraj, M. S., published a paper titled '*Anaesthetic Management of obstetric Emergency*' that claimed that obstetric emergencies are a challenge for practitioners. Cesarean delivery is classified based on urgency into four categories. Complications such as haemorrhage, thromboembolism, and maternal collapse. They perform investigation, classification, and management of CS based on urgency. They also considered complications and techniques of anesthesia. Rapid assessment and management of obstetric emergencies with proper technique is required. During the CS, spinal technique is preferred over GA. In emergencies, the risk of failed intubation and aspiration is higher during anesthesia [9].

In 2019, Fernandes, N. L. and Dyer, R. A. published a paper entitled '*Anesthesia for Urgent Cesarean Section*' that says emergency cesarean delivery may require GA due to obstetric and fetal complications. To prevent fetal compromise, continuous oxygen supply to the mother is necessary. Quick response to intrapartum hypoxia is important for neonatal outcomes. They investigate Decision-to-delivery (DDI) in different anesthesia for emergency cesarean delivery. The author compares the effect of epidural top-up and CSE anesthesia on DDI. They analyze the time intervals for GA, epidural top-up, and SA. The author preferred RA for urgent cesarean delivery. Epidural reduces DDI interval in all Body Mass Index (BMI) groups. In Kenya Training nonphysician practitioners in GA for cesarian deliveries. To ensure safety, RA is preferred over GA for urgent CS. There is no significant neonatal impact of induction agents in emergency cesarian. Patients with stable eclampsia can safely receive RA for CS [10].

In 2019, Khan, Z. H., et al. published an article titled '*General versus Spinal Anesthesia During Cesarean Section: A Narrative Review*' in which they compare RA and GA in CS and prefer SA. People commonly use GA in emergency CS. With the use of regional anesthesia, maternal mortality has been reduced. The author compares spinal and GA outcomes for C-sections. They also assess the effects of different anesthesia techniques on maternal and neonatal outcomes. In this review, SA is better for cesarean delivery in patients with severe preeclampsia. They conclude that SA is better than general anesthesia, except in emergent cases where GA is commonly used [11].

In 2020, Shen, C., et al. published an article entitled '*Extending epidural analgesia for intrapartum cesarean section following epidural labor analgesia: a retrospective cohort*

study'. In this, the author gives an effective and reliable method of anesthesia with the fewest side effects during cesarean delivery. This study is based on extending EA for intrapartum CS. They analyzed 1254 patients for anesthesia methods and outcomes. For intrapartum CS, they summarize anesthesia process data for anesthesia management. They also determine the effectiveness of extending epidural analgesia. According to their survey, 88.2% underwent extending epidural anesthesia, and 96.5% had successful outcomes. 6.7% experienced hypotension and 12.1% had nausea and vomiting. For a 1-minute neonatal Apgar score, 0.9% between 0-3 points and 0.8% between 4-7 points. They conclude that extending EA for intrapartum CS is reliable and effective. In the future, research is needed to reduce conversion anesthesia failure rates [12].

In 2020, Delgado, C., et al. published the paper '*General Anesthesia in Obstetrics*' that reports mortality associated with GA and airway complications. They considered physiological changes in pregnancy and fetal considerations practiced safe anesthesia and harvested good outcomes. They described the management of failed tracheal intubation. According to their survey, maternal mortality associated with GA has reduced nearly 60% from 1979-2002. They report a reduction in the use of GA from 35% to less than 25% by 2011. Airway-related maternal mortality during obstetric GA is approximately 2.3 per 100,000 GA. In obstetrics, the safest and most common method is RA but for emergent cases, GA is the only option. The use of video laryngoscopes enhances the success of Rapid Sequence Induction (RSI) in parturient [13].

In 2021, Iddrisu, M., and Khan, Z. H. published a paper titled '*Anaesthesia for Caesarean delivery: general or regional anesthesia - A systematic review*' attempted to compare GA and RA for CS to evaluate the fetal and maternal metrics using the pH scale and Apgar score. The author concluded that RA produced better results for both the mother and the fetus, while GA resulted in more intraoperative blood loss and hypotension and less postoperative analgesia. The superiority of RA for cesarean delivery was determined by the authors [14].

In 2021, Al-Husban, N., et al. published the title '*Anesthesia for cesarean section: a retrospective comparative study*' that tried to Compare the anesthetic types for maternal and neonatal outcomes in cesarean delivery and assess the satisfaction of epidural. The authors claimed that there is no significant difference in neonate care and post-operative hospital stay. It is found that GA is preferable over spinal or epidural, and GA is used in major surgeries where longer operative time is needed. In different types of anesthesia maternal blood loss and Apgar score vary but show higher Apgar score in SA [15].

In 2022, Guglielminotti, J., et al. published the article '*Use of Labor Neuraxial Analgesia for Vaginal Delivery and Severe Maternal Morbidity*' in which they studied the use of labor neuraxial analgesia for vaginal delivery and severe maternal mortality. They collected data from New York hospitals from 2010 to 2017 and analyzed data from 2020 to 2021.

They assess the impact of labor neuraxial analgesia on severe maternal morbidity. They evaluate the relationship between labor neuraxial analgesia and severe Postpartum Haemorrhage (PPH). They found that neuraxial analgesia was linked to reduced severe maternal morbidity risk. White non-Hispanic women are more likely to experience analgesia. Labor NA reduced the risk of severe maternal mortality. Increasing access to neuraxial analgesia can improve maternal health outcomes [16].

In 2022, Bao, Y., *et al.* published a paper entitled '*A retrospective analysis of maternal complications and newborn outcomes of general anesthesia for cesarean delivery in a single tertiary hospital in China*'. In this, they analyze that GA during cesarean delivery is linked to maternal and neonatal complications. Use of GA has increased from 3.71% to 10.23% from 2013-2016. According to anesthesia types, neonatal outcomes differ. The author suggests different strategies to reduce maternal and neonatal complications. Examples of maternal complications are massive haemorrhage, respiratory issues, and MAP. In the case of GA, neonatal outcomes showed lower Apgar and higher NICU admissions. Repeat cesarean delivery increased significantly from 16.22% to 54.14%. For airway management during cesarean delivery, airway devices should be used safely [17].

In 2022, Choi S. U., published the title '*General Anesthesia for Cesarean Section: Are We Doing it Well?*' that tried to focus on improving skills and knowledge in performing GA in obstetrics. General anesthesia for cesarean delivery has evolved with advancements in drugs, devices, and techniques. It also reduces the impact of anesthesia-related MMR. For cesarean delivery under general anesthesia, Rapid-Sequence Induction and Intubation (RSII) with cricoid pressure using thiopental and succinylcholine has been the standard procedure [2]. Anesthetic management for post-delivery involves considerations such as the use of short-acting benzodiazepines, opioids, nitrous oxide, and Total Intravenous Anesthesia (TIVA) to ensure minimal effects on the neonate and uterine contractions. There should be regular practice and updates in improving skills as Obstetric anesthesiologists [18].

In 2023, Kurdi, M. S., *et al.* published the article '*Recent advancements in regional anesthesia*' which focuses on safe and advanced methods of RA for example novel nerve blocks and ultrasound techniques. For better analgesic effect Liposomal bupivacaine and adjuncts like clonidine and dexmedetomidine enhance local anesthesia outcomes. They investigate advanced SA techniques which are real-time and ultrasound-guided. They address the limitations of ultrasound-guided blocks for a range of clinical applications. They establish a research network globally for RA research and raise funding for studies. They consider patient safety and improve outcomes in regional techniques. They make us aware of the advancement in ultrasound-guided nerve blocks and continuous local anesthesia infiltration. They face challenges such as expenditure, training, and underutilization of USG-guided techniques [19].

In 2023, Joo Y. J., *et al.* published a research article '*Comparison of Neonatal Outcomes among Patients Undergoing Cesarean Delivery under General or Spinal Anesthesia*' which primarily compares neonatal outcomes in cesarean under different types of anesthesia. In emergencies, GA is used, but due to lower risks, SA is preferred. The author states that GA is associated with lower Apgar scores at 1 and 5 minutes and higher resuscitation as well as NICU admissions. They analyze the factors that affect the use of GA during cesarean delivery. They conclude SA had a better neonatal outcome, and the use of GA should be minimized until there is an emergency cesarean delivery [20].

In 2023, Ozden, M. G. N., *et al.* published a paper titled '*Comparison of the effects of general and spinal anesthesia for cesarean delivery on maternal and fetal outcomes: A retrospective analysis of data*' that compares the effects of GA and SA on obstetric and neonatal outcomes. The data from a 1-year retrospective study of 883 cesarean deliveries concludes that GA has a higher NICU need than spinal as it has higher Apgar scores than GA. Lower umbilical cord blood Ph. and higher PCO₂ values with SA. The author said that both anesthetic techniques can be used safely [21].

In 2024, Shi, X., *et al.* published a paper entitled '*Perinatal outcome of the emergency cesarean section under neuraxial anesthesia versus general anesthesia: a seven-year retrospective analysis*' which analyzes the effect of anesthesia on maternal and neonatal outcome in emergency cesarean. They evaluate Apgar scores, DDI, Decision to Incision Interval (DII), maternal complications, and neonatal outcomes. The effects of epidural, general, and combined spinal-epidural anesthesia techniques were evaluated. There is a comparison between general and NA in emergent cases. Verify the effects of anesthesia on the outcomes of mothers and newborns. They found GA is associated with lower Apgar and more neonatal complications than spinal and epidural. There is no negative impact on neonatal and maternal outcomes in epidural. Under epidural anesthesia, a brief DDI was accomplished for an emergency cesarean [22].

In 2024, Karunarathna, I., *et al.* published the title '*Anesthesia Considerations for Pregnant Patients: Physiological Changes, Drug Transfer, and Safety Implications*' that tried to focus on understanding how pregnancy-related physiological change affects anesthetic management and helps to give safely and effectively. According to the author, pregnancy-related anesthesia practice must take fetal safety and possible teratogenic effects into account. They consider factors that affect anesthetic management are respiratory mechanics, cardiovascular dynamics, drug pharmacokinetics, and fetal safety. They considered the risk of hypoxemia, hemodynamic instability, and altered drug metabolism for safe practice. Anesthesiologists can improve outcomes for parturients and fetal by incorporating these factors into their clinical practice [23].

In 2024, Patel, S. and Ninave, S., published the article '*Post spinal Anaesthesia Hypotension in Cesarean Delivery: A*

Narrative Review' on post-spinal hypotension in parturient for patients' safety and care. The use of Artificial Intelligence (AI) technologies increases the efficiency and depth of research analysis. By leveraging insights from the review, it improves patient outcomes. The author focuses on identifying and managing post-spinal hypotension in C-Sections for patient safety. Prevention and management of post-spinal hypotension where vasopressors are recommended and it requires careful treatment [8].

In 2024, Singh, R. K., *et al.* published a paper article, '*Comparative study of spinal anaesthesia and general anaesthesia for cesarean section in a tertiary care hospital: Maternal and neonatal outcomes*' In this they compared SA and GA for cesarean delivery. Spinal anesthesia is favorable for maternal satisfaction, pain control, and neonatal outcomes. Compared spinal and GA for CS outcomes. Assess maternal and neonatal outcomes for cesarean deliveries. SA had lower pain scores, less Postoperative nausea and vomiting (PONV), and earlier mobilization. Maternal satisfaction was higher in the SA group. SA group had higher 1-minute Apgar scores and less resuscitation. Breastfeeding initiation within 1 hour was more frequent in the SA group. Spinal anesthesia is favored for CS due to better outcomes. General anesthesia remains valuable in emergencies or contraindications [24].

3. Proposed Work

After performing a primary data collection of 34+ articles of the field, most considerable 16 have been included in the

literature review and an extensive survey of the literature has been performed. The survey includes only peer-reviewed manuscripts published in national and international journals of repute that are indexed in SCI, ESCI, SCIE, and SCOPUS. After going through a critical analysis of the literature (refer to section 2), a comparative study of the works based on effective parameters such as *anaesthetic management*, *Apgar Score*, *maternal and/or neonatal outcomes*, *maternal complications*, *maternal mortality*, *obstetric emergencies*, and *anesthetic preference* is shown below in Table 1. Figure 2 represents the paper selection criteria versus the year of publication.

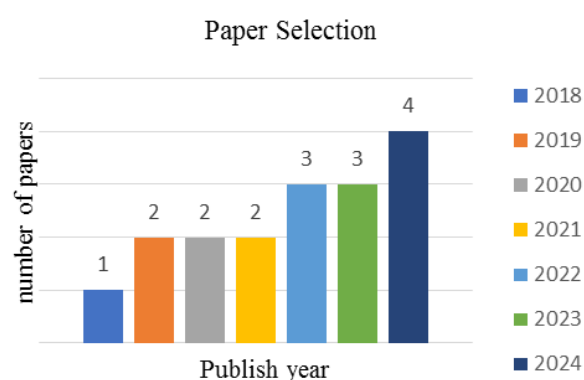


Figure 2. Graphical representation of paper selection.

The Following Table represents a comparative study of the work.

Table 1. Comparative study of anaesthesia on various parameters.

Author(s)	Anaesthetic Management	Apgar Score	Maternal and/or Neonatal Outcomes	Maternal Complications	Maternal Mortality	Obstetric Emergencies	Anaesthetic Preference
Dongare, P. A. and Nataraj, M. S. [9]	For emergency CS: aspiration prophylaxis, positioning, preoxygenation, RSII with cricoid pressure, monitoring	Not mentioned	Reduced by rapid assessment, team effort, and obstetrician intervention	Haemorrhage, thromboembolism, failed intubation, Pulmonary aspiration, and failed neuraxial block	Reduced by rapid assessment, team effort, and an obstetrician involvement	The challenge for practitioners. Rapid assessment and management required	Rapid sequence SA is an alternative but GA is preferable
Fernandes, N. L. and Dyer, R. A. [10]	RSI with video laryngoscopy, supraglottic airway. Phenylephrine is preferred in spinal hypotension	Under GA 5-minute Apgar score <7	Poor neonatal outcomes in GA for CS. Neonatal outcomes were similar in other studies.	Delayed DDI for emergent cesarean	Due to haemorrhage during or after CS; hypertensive disorders, puerperal sepsis	RSII is the safest management option in urgent CS	RA preferred over GA for urgent C-section
Khan, Z. H., <i>et</i>	Not mentioned	Lower with GA. SA	Further research is required to evalu-	Severe preeclamps-	Maternal mortality	GA is commonly used in	SA is better than GA except for

Author(s)	Anaesthetic Management	Apgar Score	Maternal and/or Neonatal Outcomes	Maternal Complications	Maternal Mortality	Obstetric Emergencies	Anaesthetic Preference
<i>al.</i> [11]		with PDPH, which causes lower Apgar	ate neonatal and maternal outcomes	sia, PDPH	reduced with RA	emergent cases	emergency
Shen, C., <i>et al.</i> [12]	Not mentioned	11/1254 newborns: 0-3 107/1254 newborns: 4-7 1136/1254 newborn: 8-10	88.2% under EA, 96.5% with successful outcome, 6.7% with hypotension, 12.1% had nausea and vomiting	The GA technique might have complications	Higher incidence of maternal mortality with GA	An extreme fetal distress, uterine rupture	Extending EA is effective and reliable
Delgado, C., <i>et al.</i> [13]	Management of difficult intubation in obstetrics. Tracheal extubation and postoperative management	Not mentioned	Major advances in obstetric anesthesia resulted in improved maternal outcomes.	Failed tracheal intubation, risk of aspiration, and aspiration pneumonia	Airway-related maternal mortality during GA is approx. 2.3 per 100,000 GA for CS	For emergent cases, GA is the only option	RA is a comparatively safe and common method except for emergent Cesarean
Iddrisu, M., and Khan, Z. H. [14]	Not mentioned	Higher Apgar scores in SA than in GA	RA is better for fetal and maternal outcomes	RA complications such as hypotension, local anesthetic toxicity, PDPH, and nerve damage	Significant maternal and fetal mortality do exist.	Failed intubation, failed ventilation, aspiration, and fetal depression in GA	RA is preferred for CS.
Al-Husban, N., <i>et al.</i> [15]	Good pain management is an important priority for women having CS	Varies with anaesthesia type, higher in SA	Compare anaesthesia type on maternal and neonatal outcomes	Preeclampsia, PTE, amniotic fluid embolism, obstetric haemorrhage, and cardiac disease	The rate is much higher in CS than vaginal delivery	Not mentioned	GA is preferable over spinal/epidural. GA used in longer operative time
Guglielminotti, J., <i>et al.</i> [16]	Not mentioned	Not mentioned	Maternal outcome can improve with labor neuraxial analgesia	PPH	Neuraxial analgesia reduces maternal mortality risk	Not mentioned	Neuraxial analgesia is associated with a 14% decrease in the risk of maternal morbidity
Bao, Y., <i>et al.</i> [17]	LMA used safely in airway management	Lower in GA than neuraxial anaesthesia	Neonatal outcomes differ in different anaesthesia types	Morbidly adherent placenta (MAP)	In India, maternal mortality in patients with MAP accounts for 30%	Not mentioned	Not mentioned
Choi S. U., [2, 18]	Aspiration prophylaxis includes RSII with cricoid pressure. Post-delivery management includes opi-	Propofol tends to have Apgar of 7 or less compared with thio-pental	Not mentioned	Related to airway management and a high incidence of difficult or failed intubation	Advancements in drugs, techniques, and devices reduce the MMR	Not mentioned	NA is the gold standard but there are some cases in which GA is inevitable

Author(s)	Anaesthetic Management	Apgar Score	Maternal and/or Neonatal Outcomes	Maternal Complications	Maternal Mortality	Obstetric Emergencies	Anaesthetic Preference
	oids, TIVA						
Kurdi, M. S., <i>et al.</i> [19]	Safe and advanced method of RA	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Advanced method of RA. Ultra-sound-guided nerve block
Joo Y. J., <i>et al.</i> [20]	Not mentioned	GA is associated with lower Apgar at 1 and 5 minutes	SA is associated with better neonatal outcomes. Minimize the use of GA to improve outcomes	GA associated with risks and complications for both mothers and newborns	Placenta previa is associated with mortality and morbidity, including maternal haemorrhagic morbidity	Placenta previa, high BP, liver dysfunction unstable vital signs, and fetal distress	Consider neuraxial techniques as the preferred choice over GA
Ozden, M. G. N., <i>et al.</i> [21]	Anaesthetic technique can be used safely	SA has higher Apgar score than GA	SA is safer in terms of neonatal outcomes. CSE need was higher in the GA	Preeclampsia, placental abruption, and placenta previa. non-progressive labor, breech presentation, and head and pelvis incompatibility	Not mentioned	Not mentioned	Both spinal and general techniques can be used safely
Shi, X., <i>et al.</i> [22]	Not mentioned	GA associated with lower Apgar score	Analyze the effect of anaesthesia on outcomes. In epidural no negative outcome found	Complications of difficult airways, aspiration of gastric content	There has reduction in anaesthesia-associated mortality	In emergency caesarean they analyze the effect of anaesthesia and outcome	Epidural anaesthesia is preferred as it has no negative impact on outcome
Karunarathna, I., <i>et al.</i> [23]	Anaesthetic management affecting factors: respiratory mechanics, cardiovascular dynamics, drug pharmacokinetics, and fetal safety	Not mentioned	Anaesthesiologists can tailor perioperative care to optimize outcomes and minimize complications	Consider the risk of hypoxemia, hemodynamic instability, and altered drug metabolism	Not discussed	Not discussed	Not discussed
Patel, S. and Ninave, S., [8]	Identifying and managing post-spinal hypotension in C-sections where vaso-pressors are used	Not mentioned	Prevention and management of post-spinal hypotension improve patients' outcomes	Post-spinal hypotension	Not discussed	Not mentioned	SA is favored for elective Caesarean delivery
Singh, R. K., <i>et al.</i> [24]	Management of hypotension with fluid administration and vasopressors to maintain maternal BP	Neonates in the SA group had slightly higher 1-minute Apgar scores	Postoperative pain scores at 6 hours, were significantly lower in the SA compared to the GA. Superior postoperative analgesia provided by NA	SA-related PDPH, hypotension. GA-related complications particularly failed intubation and aspiration	Mortality and morbidity associated with GA complications	Not mentioned	SA was associated with lower post-operative pain. Maternal satisfaction was higher in the SA group.

4. Result Discussions

Based on the data/ facts/ information listed in [Table 1](#) (refer to Section 3), the following observations have been found:

4.1. Anaesthetic Management

Cesarean sections are classified depending on the urgency into four categories as listed below in [Table 2](#).

Table 2. Classification of cesarean based on urgency.

Category	Definition	Indications
1	The immediate threat to the life of the mother or fetus	Placental abruption, uterine rupture, active bleeding, severe fetal distress and cord prolapse
2	Maternal or fetal compromise, that is not immediately life-threatening	Breech presentation, previous c-section, and non-reassuring fetal status
3	No maternal or fetal compromise but needs early delivery	Low amniotic fluid index (AFI) and previous c-section not in labor
4	At a time to suits the mother and the maternity team	---

Emergency management involves a rapid assessment, with minimal investigations. RSII during GA is a choice in the category 1 CS. *Aspiration prophylaxis*: H2 receptor antagonists (Ranitidine 50 mg intravenously) or proton-pump inhibitors (e.g., pantoprazole 40 mg intravenously) and prokinetic agents such as metoclopramide 10 mg intravenously, head up tilt position. Sodium citrate is also preferred because of its advantage of rapid action. In category 2 and 3 CS, SA remains the technique of choice. To avoid post-spinal hypotension, vasopressors like ‘phenylephrine’ are used. Left lateral tilt is recommended to avoid aorto-caval compression. Opioids are usually avoided in obstetric cases till the extraction of the fetus due to placental transfer of the drug and known incidence of low APGAR in neonates. Supraglottic airway devices are rescue devices in difficult intubation also use of video laryngoscopy is preferred. Monitoring vitals during the perioperative period is found to be beneficial. End-tidal carbon dioxide (ETCO₂) monitoring confirms tracheal intubation and is used to titrate anesthetic depth. Factors affecting anesthetic management are respiratory mechanics, cardiovascular dynamics, drug pharmacokinetics, and fetal safety.

4.2. Apgar Score

Apgar is a quick test performed on a baby at 1 and 5 minutes after birth. The 1-minute score tells, how well the baby tolerated the birthing process. The 5-minute score tells, the healthcare provider how well the baby is doing outside the mother's womb. The Apgar score is based on a total score of 1 to 10. The higher the score, the better the baby is doing after birth. Under GA where a 5-minute score < 7. It is observed, a higher score in SA than in GA. Lower Apgar in GA than NA. Neonates born under SA had a higher 1-minute score.

4.3. Maternal and Neonatal Outcome

Neonatal outcome differs in different anesthesia types. In SA, post-operative pain was less as compared to general anesthesia. The maternal and neonatal outcomes were poor in GA however RA is observed to have better maternal and neonatal outcomes.

4.4. Maternal Complications

Maternal complications during delivery in the case of obstetrical anesthesia can vary widely and have significant implications for both the mother and the newborn. Here are some common complications:

- Hypotension: A common complication associated with RA, such as epidurals and spinal blocks, is maternal hypotension.*
- Respiratory Complications: General anesthesia, can lead to difficult intubation, aspiration, or respiratory depression.*
- High Spinal or Total Spinal Anesthesia: This occurs when the LA spreads too high in the spinal column, potentially leading to severe hypotension, respiratory depression, or even loss of consciousness.*
- PDPH: A complication of epidural or SA, occurring when there is an accidental puncture of the dura mater, leading to a leakage of cerebrospinal fluid and a severe headache.*
- Local Anesthetic Systemic Toxicity (LAST): This can occur if local anesthetic agents are absorbed systemically in toxic amounts, leading to symptoms ranging from mild (tinnitus, metallic taste) to severe (seizures, cardiac arrest).*
- Uterine Atony and PPH: Anaesthesia, particularly GA,*

can sometimes contribute to uterine atony, where the uterus fails to contract effectively after delivery, leading to severe bleeding.

- g) *Aspiration: During general anesthesia, there is a risk of aspiration where gastric content goes into the lungs, which can cause aspiration pneumonia.*
- h) *Awareness during Anesthesia: Description: Rare but serious, awareness under GA can occur, leading to psychological trauma.*

Table 3. Types of obstetric emergencies.

#	Surgical	Anesthetic
1	Haemorrhage	Failed intubation
2	Thromboembolism	Pulmonary aspiration
3	Delayed extraction and risk to a fetus	Failed neuraxial block
4	Amniotic fluid embolism	Allergic reactions
5	Maternal collapse	Awareness during anesthesia
6	---	Extensive SA

4.5. Maternal Mortality

Intra-operative or post-operative haemorrhage is said to be the leading cause of mortality worldwide. Airway-related maternal mortality is higher with GA. Higher mortality in cesarean than vaginal delivery. It is observed that maternal mortality risk is reduced with RA. Recent advancements in drugs, techniques, and devices reduce MMR. It is also reduced by rapid assessment, team effort, and obstetrician involvement.

4.6. Obstetric Emergencies

Obstetric emergencies are acute, life-threatening conditions that occur during pregnancy, at delivery, or during the postpartum period. These situations require rapid assessment and management to prevent maternal and neonatal complications. It is a challenge for practitioners. Obstetric emergencies are acute, life-threatening conditions that occur during pregnancy, labor, delivery, or the postpartum period. These situations require immediate. Below are some common obstetric emergencies:

- a) *PPH: is defined as the loss of more than 500 mL of blood after vaginal delivery or more than 1,000 mL after a CS.*
Causes; Uterine atony (failure of the uterus to contract), retained placental tissue, uterine rupture.
- b) *Eclampsia: Episodes of seizures with high blood pressure and proteinuria. It can occur during pregnancy, labor, or postpartum.*

- c) *Placental Abruption (Abruptio Placentae): the placenta detaches from the uterine wall before delivery, leading to bleeding and compromising the oxygen supply to the fetus.*
- d) *Placenta previa: It's a condition where the placenta partially or completely covers the cervix, leading to painless vaginal bleeding in the second or third trimester.*
- e) *Uterine rupture: A tear in the uterine wall, often associated with a previous CS scar or other uterine surgery, leading to life-threatening bleeding and risk to both mother and baby.*
- f) *Prolapsed Umbilical Cord: the umbilical cord slips down into the vagina ahead of the baby, leading to cord compression and reduced oxygen supply to the fetus.*
- g) *Preeclampsia: Characterized by high blood pressure and proteinuria after 20 weeks of pregnancy.*

As we can see, the safest management in an obstetric emergency is cesarean delivery under GA with RSI. Emergencies associated with GA are failed intubation, failed ventilation, gastric aspiration, and fetal depression.

4.7. Anaesthetic Preference

Regional anesthesia is the safest method and it is preferred over GA except for emergency cesarean. Spinal anesthesia is preferred due to maternal satisfaction and less post-operative pain. In some cases, GA is inevitable while neuraxial anaesthesia is considered the gold standard. Epidural anaesthesia has no negative maternal and neonatal outcomes. For emergent cesarean RA is preferred but GA is preferable.

5. Conclusion

The safest and most common method of anaesthesia is the regional technique for non-emergent obstetric cases. The study observed that airway-related maternal mortality is higher in GA and reduced with RA. On the other hand, aspiration prophylaxis and patient positioning are also important considerations. In case of difficult intubation, the use of supraglottic airway devices or video laryngoscopy is often preferred. At the time of delivery, the maternal physiological changes should be kept in mind. It has also been observed that, under GA, the 1 and 5-minute Apgar score is always found less than 7 and SA has a higher Apgar score than GA. Additionally, maternal outcomes in SA are much more feasible and yield less post-operative pain compared to GAs. Also, the maternal and neonatal outcomes are less feasible in GA as found in RA, however, some potential maternal complications like hypotension, local anaesthetic systemic toxicity, respiratory depression, and PDPH are associated with RA. It has been noticed that maternal complications like difficult intubation, aspiration pneumonia, PPH, and uterine atony are also associated with GAs. No anaesthesia is ideal in every situation; hence, it is impossible to come up with a precise

anaesthesia type that performs excellently in all cases. We have to delve deeper into anatomical and physiological changes in pregnancy, the mechanism of labor pain and clinical management.

In a nutshell, further research is needed to determine the feasible anaesthesia type that yield better outcome. Some potential future works are, to enhance skills in airway management and difficult intubation, real-time perioperative monitoring of maternal hemodynamics, reduction of post-partum depression, proper teamwork and communication under debriefing, and all non-clinical skills may be suggested.

Abbreviations

AI	Artificial Intelligence
AFI	Amniotic Fluid Index
BMI	Body Mass Index
CS	Cesarean Section
CSE	Combined Spinal-Epidural
CSEA	Combined Spinal-Epidural Anaesthesia
DDI	Decision-to-delivery
DII	Decision to Incision Interval
ETCO ₂	End-tidal Carbon Dioxide
FRC	Functional Residual Capacity
GA	General Anaesthesia
GIT	Gastrointestinal Tract
HR	Heart Rate
LAST	Local Anesthetic Systemic Toxicity
MAP	Morbidly Adherent Placenta
MMR	Maternal Mortality Rate
MR	Mortality Rates
MV	Minute Ventilation
NA	Neuraxial Anesthesia
NICU	Neonatal Intensive Care Unit
PDPH	Post-dural Puncture Headache
PONV	Postoperative Nausea and Vomiting
PPH	Post-partum Haemorrhage
RA	Regional Anaesthesia
RBC	Red Blood Cell
RSI	Rapid Sequence Induction
RSII	Rapid-Sequence Induction and Intubation
TIVA	Total Intravenous Anesthesia
WHO	World Health Organization

Ethical Approval

Not Applicable.

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Conflicts of Interest

The author declares no conflicts of interest.

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