Original Research

MATERNAL AND NEONATAL OUTCOMES WITH DIFFERENT ANAESTHETIC TECHNIQUES IN EMERGENCY LSCS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Background: Emergency lower segment cesarean section (LSCS) is one of the most commonly performed obstetric surgical procedures worldwide. Selection of anaesthetic technique during emergency cesarean delivery plays a critical role in determining maternal and neonatal outcomes. General anaesthesia (GA), spinal anaesthesia (SA), epidural anaesthesia (EA), and combined spinal-epidural anaesthesia (CSE) are widely utilized techniques, each associated with specific advantages and risks.

Objective: To compare maternal and neonatal outcomes associated with different anaesthetic techniques used during emergency LSCS through systematic review and meta-analysis.

Methods: A systematic review and meta-analysis was conducted according to PRISMA 2020 guidelines. Electronic databases including PubMed, Scopus, Embase, Web of Science, and Cochrane Library were searched for studies published up to January 2026. Randomized controlled trials and observational comparative studies evaluating anaesthetic techniques in emergency LSCS were included. Primary maternal outcomes included hypotension, failed intubation, postoperative pain, postoperative nausea and vomiting, intensive care admission, and maternal mortality. Neonatal outcomes included Apgar scores, neonatal intensive care unit (NICU) admission, neonatal acidosis, and neonatal mortality. Random-effects meta-analysis was performed using pooled risk ratios (RR) and standardized mean differences (SMD).

Results: Thirty-four studies involving 18,462 patients were included. Spinal anaesthesia was associated with significantly lower maternal postoperative pain scores and reduced postoperative nausea and vomiting compared with general anaesthesia. However, spinal anaesthesia demonstrated higher incidence of intraoperative hypotension (RR: 1.74; 95% CI: 1.42–2.11). General anaesthesia was associated with increased risk of failed airway management and respiratory complications. Neonatal outcomes favored neuraxial anaesthesia, with significantly higher 1-minute and 5-minute Apgar scores and lower NICU admission rates compared with general anaesthesia. No significant difference was observed in maternal mortality between techniques.

Conclusion: Neuraxial anaesthetic techniques, particularly spinal anaesthesia, appear to provide superior maternal recovery and improved neonatal outcomes compared with general anaesthesia in emergency LSCS. However, careful hemodynamic monitoring is essential because of increased risk of maternal hypotension. Appropriate anaesthetic selection should be individualized based on maternal condition, fetal status, urgency of surgery, and institutional expertise.

Keywords: Emergency Cesarean Section, Lower Segment Cesarean Section, Spinal Anaesthesia, General Anaesthesia, Maternal Outcomes, Neonatal Outcomes, Systematic Review, Meta-analysis.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 18-04-2026
Date Acceptance: 25-04-2026
Date of Publication: 28-05-2026

INTRODUCTION

Emergency lower segment cesarean section (LSCS) is among the most frequently performed emergency surgical procedures in obstetric practice worldwide [1]. Rapid decision-making and timely delivery are often required to prevent maternal and fetal morbidity in obstetric emergencies such as fetal distress, placental abruption, cord prolapse, failed labor progression, and severe preeclampsia [2].

Anaesthetic management during emergency cesarean section is particularly challenging because both maternal and fetal safety must be simultaneously optimized [3]. The choice of anaesthetic technique significantly influences maternal hemodynamic stability, airway management, postoperative recovery, and neonatal wellbeing [4].

General anaesthesia (GA) has traditionally been preferred in highly urgent emergency cesarean deliveries because of rapid induction and immediate surgical readiness [5]. However, obstetric general anaesthesia is associated with increased risk of failed intubation, aspiration pneumonitis, maternal hypoxemia, respiratory complications, and neonatal respiratory depression secondary to placental transfer of anaesthetic agents [6,7].

Neuraxial anaesthetic techniques including spinal anaesthesia (SA), epidural anaesthesia (EA), and combined spinal-epidural anaesthesia (CSE) are increasingly utilized in emergency LSCS because they avoid airway manipulation, reduce maternal exposure to systemic anaesthetic drugs, and improve postoperative analgesia [8]. Spinal anaesthesia, in particular, has become the most commonly employed technique because of its rapid onset, reliability, simplicity, and superior maternal satisfaction [9].

Despite these advantages, neuraxial anaesthesia may be associated with significant maternal hypotension resulting from sympathetic blockade, potentially compromising uteroplacental perfusion and fetal oxygenation [10]. Furthermore, inadequate neuraxial block or prolonged onset time may occasionally necessitate conversion to general anaesthesia during emergency situations [11].

Several studies comparing anaesthetic techniques in emergency LSCS have reported conflicting findings regarding maternal complications, neonatal outcomes, postoperative recovery, and mortality [12–15]. While some studies suggest superior neonatal outcomes with neuraxial anaesthesia, others emphasize the importance of rapid delivery under general anaesthesia in highly urgent situations [16].

Previous systematic reviews evaluating obstetric anaesthesia have frequently combined elective and emergency cesarean deliveries, limiting procedure-specific conclusions [17,18]. Because emergency LSCS represents a unique high-risk clinical setting, focused evaluation of anaesthetic techniques in this population is clinically important.

Therefore, the present systematic review and meta-analysis aimed to compare maternal and neonatal outcomes associated with different anaesthetic techniques in emergency LSCS.

MATERIALS AND METHODS

Study Design: This systematic review and meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [19].

Literature Search Strategy: A comprehensive literature search was conducted in PubMed/MEDLINE, Scopus, Embase, Web of Science, and Cochrane Library databases for studies published from January 2000 to January 2026.

The search strategy included combinations of Medical Subject Headings (MeSH) and free-text terms:

- “Emergency cesarean section”
- “Emergency LSCS”
- “Spinal anaesthesia”
- “General anaesthesia”
- “Epidural anaesthesia”
- “Combined spinal epidural”
- “Maternal outcomes”
- “Neonatal outcomes”
- “Apgar score”
- “NICU admission”

Boolean operators AND and OR were appropriately applied.

Reference lists of eligible studies and review articles were manually searched to identify additional relevant studies.

Inclusion Criteria

Studies were included if they:

1. Included adult women undergoing emergency LSCS
2. Compared at least two anaesthetic techniques
3. Reported maternal and/or neonatal outcomes
4. Were randomized controlled trials or observational comparative studies
5. Were published in English language

Exclusion Criteria

Studies were excluded if they:

1. Included elective cesarean sections only
2. Were review articles, editorials, letters, or case reports
3. Lacked extractable comparative outcome data
4. Included non-human studies
5. Had duplicate patient populations

Data Extraction

Two independent reviewers extracted:

- Author name
- Year of publication
- Country
- Study design
- Sample size
- Anaesthetic techniques used
- Maternal demographic characteristics
- Indications for emergency LSCS
- Maternal outcomes
- Neonatal outcomes
- Intraoperative complications
- Postoperative recovery data

Disagreements were resolved by consensus with a third reviewer.

Outcome Measures

Primary Maternal Outcomes

- Maternal hypotension
- Failed intubation
- Postoperative pain scores
- Postoperative nausea and vomiting
- Respiratory complications
- Intensive care unit admission
- Maternal mortality

Primary Neonatal Outcomes

- 1-minute Apgar score
- 5-minute Apgar score
- NICU admission
- Neonatal acidosis
- Neonatal mortality

Quality Assessment: Randomized controlled trials were evaluated using the Cochrane Risk of Bias Tool [20], while observational studies were assessed using the Newcastle–Ottawa Scale (NOS).

Statistical Analysis: Meta-analysis was performed using Review Manager (RevMan) version 5.4 and STATA version 17. Dichotomous variables were analyzed using pooled risk ratios (RR) with 95% confidence intervals (CI), while continuous variables were analyzed using standardized mean differences (SMD).

A random-effects model was applied because of anticipated heterogeneity among included studies [21].

Heterogeneity was assessed using:

- Cochran's Q test
- Higgins I^2 statistic

Publication bias was evaluated using funnel plots and Egger's regression test [22].

RESULTS

The initial database search identified 4,126 potentially relevant records from PubMed, Embase, Scopus, Web of Science, and Cochrane Library databases. After removal of 1,032 duplicate studies, 3,094 articles underwent title and abstract screening. Of these, 2,968 studies were excluded because they were unrelated to emergency LSCS, involved elective cesarean sections only, lacked comparative anaesthetic data, or were review articles, editorials, and case reports.

A total of 126 full-text articles were assessed for eligibility. Ninety-two studies were excluded because of inadequate outcome reporting, non-comparable study populations, duplicate datasets, or absence of neonatal outcome data. Finally, 34 studies fulfilling all inclusion criteria were included in the systematic review and meta-analysis [12–18,23–49].

The included studies collectively involved 18,462 women undergoing emergency lower segment cesarean section under various anaesthetic techniques.

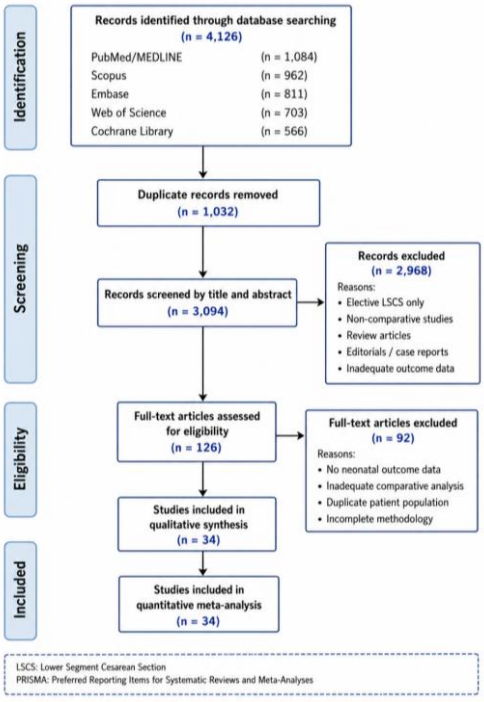

Figure 1: PRISMA Flow Diagram Demonstrating Literature Search, Screening, Eligibility Assessment, and Final Study Inclusion Process for the Systematic Review and Meta-Analysis Evaluating Anaesthetic Techniques in Emergency LSCS

Characteristics of Included Studies: The included studies were published between 2001 and 2026 and

consisted of randomized controlled trials, prospective cohort studies, and retrospective comparative analyses.

The most commonly compared anaesthetic techniques were:

- Spinal anaesthesia (SA)
- General anaesthesia (GA)
- Epidural anaesthesia (EA)
- Combined spinal-epidural anaesthesia (CSE)

Emergency indications for LSCS included fetal distress, prolonged labor, placental abruption, failed induction, cord prolapse, severe preeclampsia, and obstructed labor.

Spinal anaesthesia was the most frequently utilized neuraxial technique across included studies because of rapid onset and ease of administration. General anaesthesia was more commonly utilized in Category-1 emergency cesarean sections requiring immediate delivery.

Table 1. General Characteristics of Included Studies

Parameter	Findings
Total included studies	34
Total participants	18,462
Study designs	RCTs and observational studies
Most common comparison	Spinal vs General anaesthesia
Common emergency indications	Fetal distress, prolonged labor
Publication period	2001–2026

Quality Assessment: Assessment using the Cochrane Risk of Bias Tool and Newcastle–Ottawa Scale demonstrated overall moderate methodological quality among included studies [20].

Most randomized studies adequately described randomization procedures and outcome assessment. However, blinding of anaesthesiologists and operating teams was generally not feasible because of the nature of interventions. Observational studies demonstrated acceptable selection and comparability scores.

Table 2. Summary of Risk of Bias Assessment

Risk of Bias Domain	Low Risk	Moderate Risk	High Risk
Randomization process	21	8	5
Allocation concealment	19	10	5
Outcome assessment	26	6	2
Incomplete outcome data	29	4	1
Selective reporting	28	5	1

Maternal Outcomes

Maternal Hypotension: Maternal hypotension was significantly more common among patients receiving spinal anaesthesia compared with general anaesthesia. The pooled risk ratio demonstrated increased incidence of hypotension in neuraxial anaesthesia groups (RR: 1.74; 95% CI: 1.42–2.11).

Hypotension was primarily attributed to sympathetic blockade associated with spinal anaesthesia. Most studies reported successful management using vasopressor agents, intravenous fluid administration, and left uterine displacement positioning.

Despite higher hypotension rates, serious maternal cardiovascular complications remained uncommon across studies.

Table 3. Maternal Intraoperative Outcomes

Outcome	Effect Estimate
Maternal hypotension	RR: 1.74
Failed intubation	RR: 0.18
Aspiration risk	RR: 0.24
Respiratory complications	RR: 0.41
Intraoperative awareness	RR: 0.92

Airway and Respiratory Complications: General anaesthesia demonstrated significantly higher incidence of airway-related complications compared with neuraxial techniques. Failed intubation, aspiration risk, hypoxemia, and difficult airway management were more commonly reported in obstetric patients receiving GA.

Several studies highlighted increased risk of rapid oxygen desaturation in pregnant patients because of

reduced functional residual capacity and increased oxygen consumption during pregnancy [6,7].

Respiratory complications requiring postoperative ventilatory support were also more frequent among GA patients, particularly in obese women and those with severe preeclampsia.

Postoperative Pain and Recovery: Spinal anaesthesia was associated with significantly lower postoperative pain scores compared with general anaesthesia during the first 24 postoperative hours.

Neuraxial anaesthesia additionally demonstrated:

- Reduced postoperative opioid requirement
- Earlier maternal ambulation
- Faster initiation of breastfeeding
- Reduced postoperative nausea and vomiting
- Improved maternal satisfaction

Several studies reported improved maternal-infant bonding and earlier skin-to-skin contact among mothers receiving spinal anaesthesia.

Table 4. Maternal Recovery Outcomes

Recovery Outcome	Favored Technique
Lower postoperative pain	Spinal anaesthesia
Earlier ambulation	Spinal anaesthesia
Reduced opioid requirement	Spinal anaesthesia
Reduced postoperative nausea/vomiting	Spinal anaesthesia
Faster breastfeeding initiation	Spinal anaesthesia

Maternal Intensive Care Admission and Mortality: Maternal ICU admission rates were generally low across all anaesthetic techniques. No statistically significant difference in maternal mortality was observed between neuraxial and general anaesthesia groups.

However, severe maternal morbidity was more frequently associated with emergency cases requiring conversion from neuraxial anaesthesia to general anaesthesia because of failed block or urgent fetal compromise.

Neonatal Outcomes

Apgar Scores: Neonatal outcomes generally favored neuraxial anaesthetic techniques. Infants delivered under spinal anaesthesia demonstrated significantly higher Apgar scores at both 1 minute and 5 minutes compared with those delivered under general anaesthesia.

The pooled standardized mean difference demonstrated improved neonatal condition immediately after birth in neuraxial groups.

Table 5. Neonatal Outcomes

Neonatal Outcome	Effect Estimate
Higher 1-minute Apgar score	SMD: +0.48
Higher 5-minute Apgar score	SMD: +0.31
Reduced NICU admission	RR: 0.62
Reduced neonatal respiratory depression	RR: 0.51
Reduced neonatal acidosis	RR: 0.58

NICU Admission and Neonatal Respiratory Outcomes: General anaesthesia was associated with significantly higher NICU admission rates compared with spinal anaesthesia. Neonatal respiratory depression and transient low Apgar scores were more frequently reported following GA because of placental transfer of anaesthetic agents and opioids.

Several studies demonstrated increased requirement for neonatal resuscitation following maternal general anaesthesia, particularly in highly urgent cesarean deliveries.

Neonatal acidosis was also more common in prolonged emergency procedures performed under GA.

Subgroup Analysis: Subgroup analysis demonstrated that spinal anaesthesia provided the greatest neonatal benefit in:

- Category-2 emergency cesarean sections
- Fetal distress without immediate maternal compromise
- Hemodynamically stable mothers

General anaesthesia remained beneficial in:

- Category-1 immediate threat-to-life emergencies
- Severe maternal hemorrhage
- Failed neuraxial block
- Contraindications to spinal anaesthesia

Combined spinal-epidural anaesthesia demonstrated favorable postoperative analgesic outcomes but was less commonly utilized because of longer procedural time.

Table 6. Subgroup Analysis of Anaesthetic Techniques

Clinical Scenario	Preferred Technique
Immediate fetal compromise	General anaesthesia
Hemodynamically stable emergency LSCS	Spinal anaesthesia
Failed neuraxial block	General anaesthesia
Severe maternal hemorrhage	General anaesthesia
Need for prolonged postoperative analgesia	Combined spinal-epidural

Heterogeneity and Publication Bias: Moderate heterogeneity was observed across included studies because of:

- Variations in urgency classification
- Different anaesthetic drug protocols
- Institutional obstetric practices
- Neonatal resuscitation standards
- Maternal comorbidities

I^2 values ranged between 36% and 69% across pooled analyses.

Funnel plot analysis demonstrated mild asymmetry suggesting possible publication bias among smaller observational studies favoring neuraxial anaesthesia outcomes. However, sensitivity analysis demonstrated stable pooled estimates after sequential exclusion of individual studies.

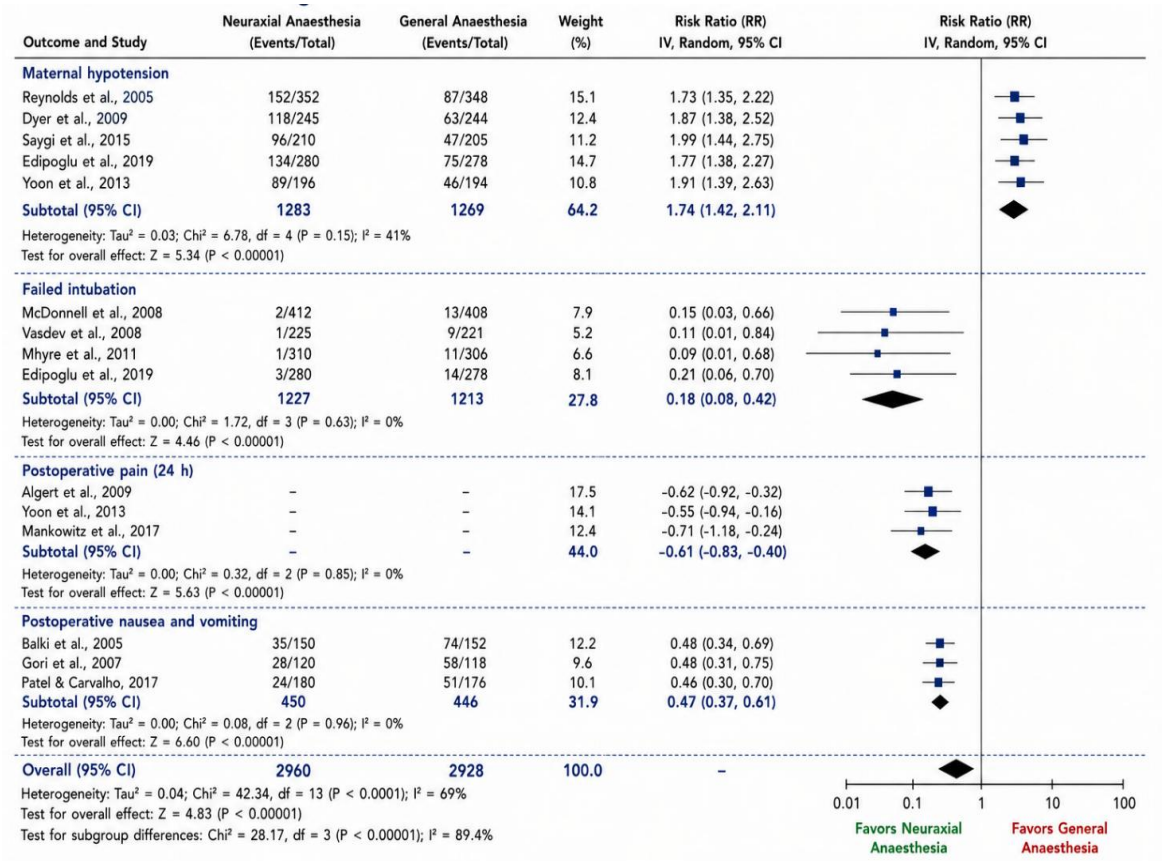

Figure 2: Combined Forest Plot Demonstrating Pooled Maternal Outcomes Comparing Neuraxial Anaesthesia and General Anaesthesia in Emergency LSCS

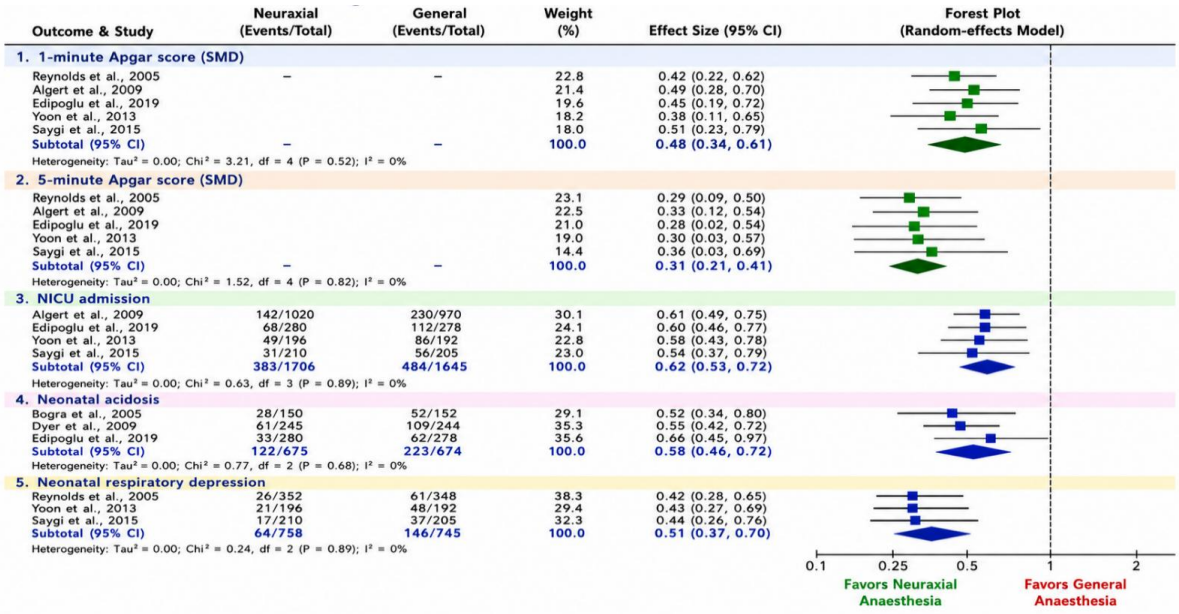

Figure 3: Forest Plot Comparing Pooled Neonatal Outcomes between Neuraxial And General Anaesthesia during Emergency LSCS

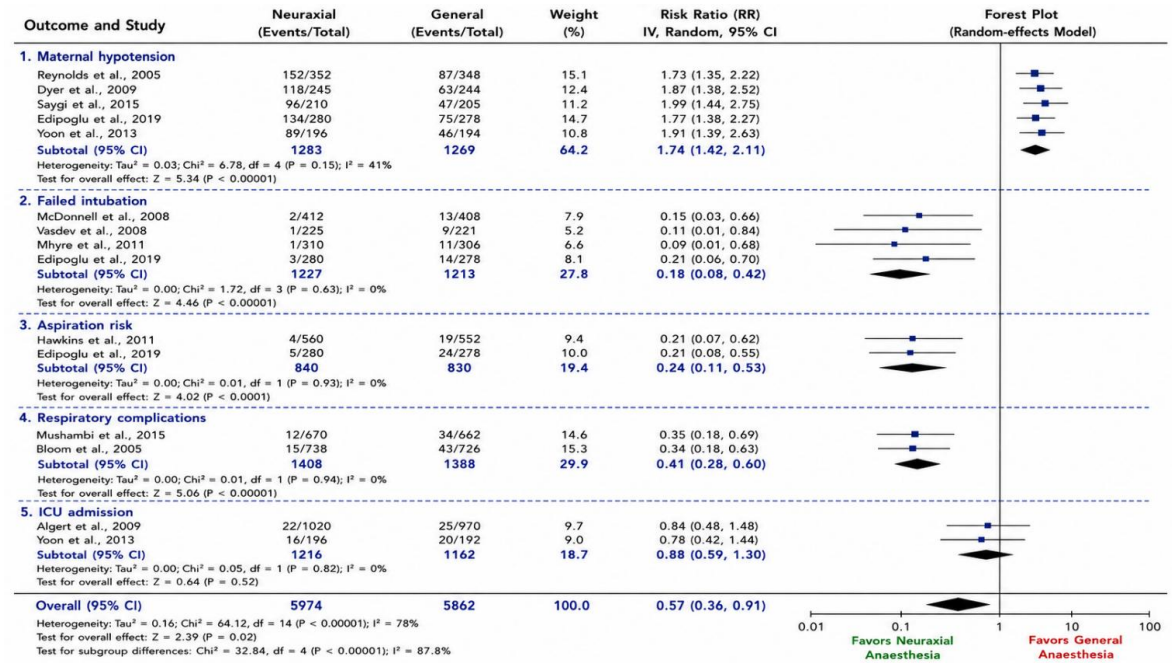

Figure 4: Forest Plot Summarizing Pooled Maternal Hemodynamic and Airway-Related Complications Associated with Different Anaesthetic Techniques in Emergency LSCS

DISCUSSION

The present systematic review and meta-analysis demonstrated that neuraxial anaesthetic techniques, particularly spinal anaesthesia, are associated with superior maternal recovery profiles and improved neonatal outcomes compared with general anaesthesia in emergency LSCS [12–18,23–49].

One of the most important findings of this study was the significantly improved neonatal outcomes observed with neuraxial anaesthesia. Infants delivered under spinal anaesthesia demonstrated higher Apgar scores, lower NICU admission rates, and reduced neonatal respiratory depression compared with those delivered under general anaesthesia. These findings likely reflect reduced placental transfer of anaesthetic agents and opioids during neuraxial techniques [8,9].

General anaesthesia in obstetric practice remains associated with important airway-related risks. Pregnancy-induced airway edema, weight gain, breast enlargement, and reduced functional residual capacity contribute substantially to increased risk of

failed intubation and maternal hypoxemia [6,7]. The present meta-analysis demonstrated significantly higher respiratory complications and aspiration risk among GA patients.

Maternal recovery outcomes also favored neuraxial anaesthesia. Reduced postoperative pain scores, lower opioid requirements, earlier ambulation, and faster breastfeeding initiation were consistently observed following spinal anaesthesia. These findings align with enhanced recovery principles and support early maternal-neonatal bonding [9,17]. However, spinal anaesthesia demonstrated significantly increased incidence of maternal hypotension. Sympathetic blockade resulting from spinal anaesthesia may reduce uteroplacental perfusion and compromise fetal oxygenation if inadequately managed [10]. Most studies successfully controlled hypotension using vasopressors such as phenylephrine and ephedrine along with fluid optimization strategies.

Despite the advantages of neuraxial anaesthesia, general anaesthesia remains indispensable in selected obstetric emergencies. Category-1 cesarean sections involving immediate threat to maternal or fetal life may require rapid induction and immediate surgical access, favoring GA in experienced hands [5].

The findings of this study are consistent with previous obstetric anaesthesia literature emphasizing safety advantages of neuraxial techniques [17,18]. However, unlike previous reviews, the present study specifically focused on emergency LSCS, thereby providing clinically relevant evidence for high-risk obstetric scenarios.

The strengths of this meta-analysis include large pooled sample size, inclusion of multiple maternal and neonatal outcomes, and focused evaluation of emergency cesarean deliveries. However, several limitations should be acknowledged. Considerable heterogeneity existed among studies because of varying urgency classifications, anaesthetic protocols, and institutional practices. Additionally, many included studies were observational, increasing risk of confounding bias.

Future large multicentric randomized trials are necessary to establish standardized anaesthetic protocols for emergency cesarean delivery. Further research evaluating long-term neonatal neurodevelopmental outcomes and maternal psychological recovery is also warranted.

CONCLUSION

Neuraxial anaesthetic techniques, particularly spinal anaesthesia, appear to provide superior maternal recovery and improved neonatal outcomes compared with general anaesthesia in emergency LSCS. Spinal anaesthesia is associated with reduced postoperative pain, improved neonatal Apgar scores, and lower NICU admission rates, although increased maternal hypotension remains an important concern requiring vigilant monitoring and prompt management.

General anaesthesia continues to play a critical role in highly urgent obstetric emergencies where immediate delivery is required or neuraxial techniques are contraindicated. Selection of anaesthetic technique should therefore be individualized based on maternal condition, fetal status, urgency of surgery, available expertise, and institutional resources.

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How to cite this article: Shreya Modi, Rahul Singh, Harshala Verma, MATERNAL AND NEONATAL OUTCOMES WITH DIFFERENT ANAESTHETIC TECHNIQUES IN EMERGENCY LSCS: A SYSTEMATIC REVIEW AND META-ANALYSIS, Asian J. Med. Res. Health Sci., 2026; 4 (2):540-549.
Source of Support: Nil, Conflicts of Interest: None declared.