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Review article

Challenges and recommendations for extubation after cesarean delivery

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Abbreviations
AIDAA – All India Difficult Airway Association
ASA – American Society of Anesthesiologists
DAS – Difficult Airway Society
ICU – intensive care unit
NAP4 – Fourth National Audit Project
OAA – Obstetric Anaesthetists' Association

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Abstract

***Background and purpose**: Extubation is the process of removing the endotracheal tube following general anesthesia and represents a critical moment in perioperative care, especially in pregnant patients undergoing cesarean section. Physiological changes during pregnancy increase the risk of complications during extubation, including rapid desaturation, airway obstruction, aspiration, and the potential need for reintubation. These complications can significantly impact maternal morbidity and prolong hospital stays. The aim of this review is to highlight the specific challenges associated with extubation after cesarean delivery, detail potential complications, and provide guidance for safe and effective extubation practices.*

***Conclusion:** Pregnancy leads to significant changes in the respiratory system such as reduced functional residual capacity, increased oxygen consumption, and airway mucosal edema, all of which heighten risks during extubation. Recommendations for safe extubation include thorough pre-extubation assessment, ensuring complete neuromuscular recovery, performing a quantitative cuff-leak test, continuous peri-extubation monitoring, and utilizing specialized airway equipment in high-risk scenarios. A multidisciplinary approach initiated early in pregnancy or upon identification of airway concerns is crucial for reducing extubation-related complications and ensuring patient safety. Adherence to recommended guidelines can reduce the risk of complications and contribute to the successful outcome of this procedure.*

INTRODUCTION

Extubation following a cesarean section is an essential procedure that necessitates meticulous consideration of multiple factors to guarantee patient safety and reduce complications. The choice to extubate should rely on a comprehensive evaluation of the patient's physiological condition, airway management, and postoperative hazards. This review integrates findings from the referenced research papers to offer a detailed overview of the factors to consider for extubation after a cesarean section. Although extubation failure is uncommon, it can elevate mortality rates, with guidelines stressing its significance and indicating a 5% mortality rate in such cases. While the incidence of airway complications during intubation has decreased, challenges with extubation remain *(1)*. The American Society of Anesthesiologists and The Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4) have reported severe outcomes following extubation failures, with a 13% rate of serious complications, underscoring the necessity for effective extubation approaches (*2,3)*.

MATERIALS AND METHODS

In order to present an overview of current practices and challenges related to extubation after cesarean section, a comprehensive literature search was conducted focusing on literature published in English between 2001 and 2024. The databases searched included PubMed (Medline), Scopus, Embase, Web of Science, and Cochrane Library. The search strategy incorporated the following key terms: airway management; airway extubation; cesarean section; pregnancy; respiratory aspiration. Studies were selected based on relevance to extubation practices, physiological challenges specific to pregnancy, and recommendations for safe airway management and monitoring in obstetric patients undergoing cesarean delivery.

RESULTS

After initial screening for eligibility based on titles and abstracts, full texts of relevant articles were reviewed in detail. From the literature reviewed, twenty-two papers were identified as particularly pertinent to this review. These articles were critically evaluated, summarized, and discussed in the next section to derive evidence-based recommendations for safe extubation practices in obstetric anesthesia.

DISCUSSION

Physiological changes during pregnancy

Pregnancy induces a wide array of physiological changes in a woman's body, which are essential for supporting fetal development and preparing the mother for childbirth. These changes affect nearly every organ system, driven primarily by hormonal fluctuations and the physical demands of the growing fetus. Understanding these changes is crucial for managing health during pregnancy and ensuring the well-being of both mother and child. Pregnancy is associated with significant physiological alterations across multiple organ systems, notably affecting cardiovascular, respiratory, gastrointestinal, hormonal, and metabolic functions. These changes profoundly influence anesthetic management, particularly in relation to airway management and perioperative care *(4)*.

Pregnancy induces significant respiratory adaptations, including upward diaphragm displacement due to uterine enlargement, which reduces functional residual capacity by 20-30%. This reduction increases the risk of rapid oxygen desaturation during apnea or hypoventilation. Additionally, upper airway swelling can cause nasal congestion and nosebleeds. These changes require careful preoxygenation and monitoring during anesthetic procedures, particularly during induction and extubation *(5)*.

Elevated progesterone and estrogen levels during pregnancy contribute significantly to airway mucosal edema and increased capillary permeability, enhancing the likelihood of airway obstruction and complications such as laryngospasm and difficult intubation or ventilation *(6,7)*.

The study conducted by Kaur et al. demonstrated that pregnancy induces considerable alterations in upper airway dimensions, notably resulting in higher Mallampati grades and reduced thyromental and sternomental distances *(8)*. Furthermore, the research highlighted that neck circumference continues to increase up until delivery, underscoring the necessity for continuous airway evaluation by anesthesiologists. This ongoing assessment is crucial to proactively address potential complications that may arise during extubation. The enlarging uterus displaces abdominal organs, leading to symptoms such as nausea, heartburn, and constipation due to delayed gastric emptying and increased intestinal transit time *(9,10)*. The gastrointestinal changes that occur during pregnancy can significantly complicate the process of extubation. These physiological alterations heighten the risk of aspiration where stomach contents may inadvertently enter the airway. This risk necessitates a thorough evaluation of airway protection strategies during extubation. Healthcare providers must be particularly vigilant in assessing the patient's risk factors, such as the presence of nausea, vomiting, or gastroesophageal reflux, which are common in pregnant individuals *(11)*. Pregnancy increases basal metabolic rate and oxygen consumption by approximately 20-30%, primarily due to fetal metabolic demands and maternal tissue growth. Enhanced metabolic requirements elevate the risk of rapid hypoxia during anesthetic induction, apnea, or inadequate ventilation. Maintaining optimal oxygenation throughout anesthesia and vigilant respiratory monitoring during extubation are crucial to avoid maternal and fetal hypoxic events (1*2)*.

Guidelines and recommendations for safe extubation

The guidelines for extubation after a cesarean section vary across different countries and organizations, reflecting differences in clinical practices and healthcare systems *(13)*. The most widely recognized guidelines for obstetric airway management, such as those from the Obstetric Anaesthetists' Association (OAA) and the Difficult Airway Society (DAS), the All India Difficult Airway Association (AIDAA), and the American Society of Anesthesiologists (ASA), focus predominantly on airway assessment, intubation strategies, and emergency response protocols, particularly in the context of difficult or failed intubation. Among these, the AIDAA 2016 guidelines for the management of anticipated difficult extubation and OAA and DAS guidelines highlight the importance of extubation planning, especially for patients with difficult airways or those with conditions like obesity and obstructive sleep apnea *(14,15)*. In contrast, the ASA guidelines,

while comprehensive in areas like anesthetic technique selection, maternal monitoring, and intraoperative management, do not include explicit recommendations or protocols for extubation following cesarean delivery. Consequently, extubation in obstetric patients is generally managed in accordance with standard anesthetic practices or institutional protocols rather than through detailed obstetric-specific guidance *(2)*.

Extubation of obstetric patients following cesarean section requires careful, structured planning due to increased airway and aspiration risks associated with pregnancy. The procedure begins with a thorough pre-extubation assessment, ensuring the patient demonstrates stable respiratory function, sufficient spontaneous breathing capacity, adequate oxygenation (PaO_2 >60 mm Hg at FiO_2 ≤40% and PEEP ≤5 cm H_2O), and full neuromuscular recovery, typically confirmed by a Train-of-Four (TOF) ratio greater than 0.95 (15, 16). Additionally, performing a quantitative cuff-leak test helps identify potential airway edema or collapse risk; a leak below the set threshold indicates increased caution *(17)*. Given the elevated risk of aspiration from hormonal and mechanical changes during pregnancy, airway management strategies must carefully consider the choice of airway device, with supraglottic airway devices like the I-gel® or Proseal® being potential alternatives in selected low-risk cases (18). Extubation should ideally be performed in a controlled environment, such as an operating theatre or intensive care unit, equipped with difficult airway carts and specialized tools, including airway exchange catheters, to promptly manage complications or facilitate rapid reintubation if needed *(14)*. Continuous monitoring throughout the peri-extubation period, focusing on oxygen saturation, respiratory rate, consciousness, and end-tidal CO_2, is crucial to rapidly detect and address any emergent complications. Post-extubation care emphasizes vigilant respiratory monitoring, individualized oxygen supplementation to prevent desaturation, and effective multimodal pain management to mitigate respiratory depression, coughing, or hypoventilation, thus ensuring optimal patient safety and recovery *(19)*.

Complications related to extubation

The Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4) showed that almost 30% of all adverse events associated with anaesthesia occurred at the end of anaesthesia or during recovery *(3)*. However, when reviewing the subset of patients related to obstetrics, no reported cases of extubation failure or related complications emerged from the ICU or emergency department data. In the broader context of the NAP4 study, analysis of extubation failure was primarily concentrated on the operating room and recovery phases in the general surgical population rather than in obstetric patients.

Post-extubation complications include desaturation, airway obstruction, aspiration, atelectasis, pneumonia, and the need for reintubation. Severe complications such as laryngospasm, bronchospasm, and airway trauma can pose immediate threats to maternal safety *(20)*. Reintubation, although infrequent, is associated with prolonged ICU stays, increased maternal morbidity, and delayed postoperative recovery *(21)*. Appropriate planning, use of predictive tools, and readiness for emergency airway management are crucial to minimizing these risks. The incidence of these complications can be minimized by using appropriate extubation techniques and ensuring adequate postextubation care *(22)*.

CONCLUSION

In conclusion, extubation after cesarean section is a multifaceted process that necessitates a thorough understanding of the unique physiological changes that occur during pregnancy, as well as the specific anesthetic considerations required for optimal patient safety. The dynamic alterations in airway anatomy and function observed in obstetric patients underscore the importance of pre-extubation assessments and vigilant monitoring throughout the extubation process. The integration of evidence-based guidelines from various organizations highlights the need for tailored approaches to airway management, particularly for patients with increased risk factors such as obesity or difficult intubation scenarios. Furthermore, the emphasis on effective postoperative care, including pain management and oxygen therapy, is essential to mitigate potential complications and enhance recovery outcomes. Effective communication among the surgical team, anesthesiologists, and nursing staff is essential to facilitate timely interventions and enhance patient safety during this critical phase of care. Future directions should focus on the development and validation of AI-driven extubation prediction tools and the implementation of large-scale, prospective studies to standardize protocols and improve individualized risk assessment in obstetric patients undergoing cesarean delivery.

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