Pediatric Anesthesia and Critical Care Journal 2025;13(2):117-121
doi:10.14587/paccj.2025.20

PACCJ

Use of neuromuscular blocking agents in obstetric anesthesiology: a comprehensive literature review

C. Pellegrino[1], S. Sorrenti[1,2], M. Ciuffreda[2], E. Pisello[2], L. Brugiaferri[1], C. Piangatelli[2], D. Galante[3]

[1]Anesthesia, Resuscitation, Intensive Care and Pain Management, Università Politecnica delle Marche, Ancona, Italy
[2]Anesthesia, Resuscitation, Intensive Care and Pain Management Unit, AST Ancona, Fabriano, Italy
[3]Anesthesia, Resuscitation, Intensive Care and Pain Management Unit, Cerignola, Italy

Corresponding author: C. Pellegrino, Resident Doctor in Anesthesia, Resuscitation, Intensive Care and Pain Management, Università Politecnica delle Marche, Ancona, Italy. Email: catello.pellegrino@gmail.com

Keypoints

The aim of this study is to analyze the pharmacological profiles, clinical indications, maternal safety, and fetal effects of neuromuscular blocking agents (NMBAs) in obstetric anesthesia, with a particular focus on the role of sugammadex in improving the management and safety of general anesthesia during cesarean delivery.

Abstract

The use of neuromuscular blocking agents (NMBAs) in obstetric anesthesiology plays a pivotal role in airway management during surgical interventions, particularly cesarean section under general anesthesia.

This review analyzes pharmacological profiles, clinical indications, maternal safety, and fetal outcomes of NMBA use in pregnancy. Recent evidence demonstrates that, when properly monitored, NMBAs are safe and effective.

Furthermore, the introduction of sugammadex has significantly enhanced maternal safety by enabling rapid and predictable reversal of rocuronium-induced neuromuscular block.

Keywords

Neuromuscular blocking agents (NMBAs), neuromuscular blockade reversal, general anesthesia, obstetric anesthesia**,** maternal safety, cesarean section.

Introduction

Obstetric anesthesia presents a unique clinical challenge due to the profound physiological changes associated with pregnancy—such as increased plasma volume, altered enzyme activity, and hormonal fluctuations—that significantly impact the pharmacokinetics and pharmacodynamics of anesthetic agents. Neuromuscular blocking agents (NMBAs) are essential for achieving skeletal muscle relaxation and facilitating tracheal intubation during cesarean delivery under general anesthesia. However, their administration requires careful biochemical consideration to ensure both maternal and fetal safety.

Discussion

Succinylcholine, a depolarizing NMBA, comprises two acetylcholine molecules linked by their acetyl groups. It binds to post-synaptic nicotinic acetylcholine receptors (nAChRs) on the motor end plate, eliciting an initial muscle contraction (fasciculations) by opening the receptor's ion channel. Unlike acetylcholine, succinylcholine is

resistant to rapid hydrolysis by acetylcholinesterase, leading to sustained depolarization and inactivation of voltage-gated sodium channels—a mechanism that underlies flaccid paralysis (Phase I block). With continued exposure, a Phase II block may ensue, mimicking non-depolarizing blockade.

Rocuronium is a non-depolarizing NMBA of the aminosteroid class. It competes reversibly for the same nicotinic receptor sites as acetylcholine, preventing depolarization and subsequent muscle contraction. Additionally, non-depolarizing agents may impair presynaptic sodium channels, disrupting acetylcholine release and further potentiating neuromuscular blockade.

Physiological changes during pregnancy—such as decreased plasma pseudocholinesterase activity frequency up to ~25–30% and increased cardiac output—can alter the onset and duration of action of both depolarizing and non-depolarizing NMBAs. Importantly, succinylcholine's clinical duration remains relatively stable, whereas rocuronium may exhibit increased or variable clearance depending on hepatic function and perfusion changes during cesarean sections.

Sugammadex, a modified γ-cyclodextrin, operates via a distinct mechanism: it contains a lipophilic cavity with eight negatively charged carboxyl-thioether side chains that tightly encapsulate aminosteroidal NMBAs like rocuronium in a 1:1 stoichiometry, forming a highly stable complex that removes free drug from plasma and creates a diffusion gradient away from the neuromuscular junction (NMJ). This encapsulation avoids the need for acetylcholinesterase inhibition, thus eliminating cholinergic side effects and rapidizing the reversal process, even in deep blocks. Sugammadex-bound complexes are renally excreted with kinetics similar to glomerular filtration rates.

Because both depolarizing and non-depolarizing NMBAs are hydrophilic, highly ionized quaternary ammonium compounds, their placental transfer is limited when administered at clinical doses; this property supports their maternal use without significant neonatal neuromuscular effects.

Pharmacology of NMBAs in Pregnancy

NMBAs act by blocking neuromuscular transmission at the motor endplate. In obstetric anesthesia, depolarizing agents such as succinylcholine and non-depolarizing agents such as rocuronium are mainly used.

Pregnancy alters plasma volume, drug distribution, renal clearance, and hepatic metabolism, all of which can influence the onset, duration, and recovery of neuromuscular blockade (AAROI-EMAC, 2018; EMC Italia).

Succinylcholine is widely used for rapid-sequence intubation because of its fast onset and short duration, but its use during pregnancy must be carefully considered due to the increased risk of hyperkalemia (EMC Italia, 2024). Rocuronium, on the other hand, represents an effective alternative with rapid onset.

The availability of reversal agents such as sugammadex has further enhanced the safety profile of rocuronium, allowing a rapid and reliable reversal of neuromuscular block (NYSORA, 2024).

Succinylcholine remains the gold standard for rapid-sequence induction due to its rapid onset (<60 seconds) and short duration (5–10 minutes), though pregnancy-associated pseudocholinesterase reduction may prolong its effect. Rocuronium is increasingly favored given its rapid onset (90 seconds) and safety profile, particularly when combined with sugammadex.

Pregnancy alters distribution volume (+30–50%) and clearance, necessitating individualized dosing strategies.

Comparative Pharmacokinetics

Succinylcholine demonstrates a rapid onset and short duration due to hydrolysis by plasma cholinesterase, while rocuronium exhibits a longer duration of action.

This pharmacological difference is particularly relevant when sugammadex is available for rapid and reliable reversal (Fig.1).

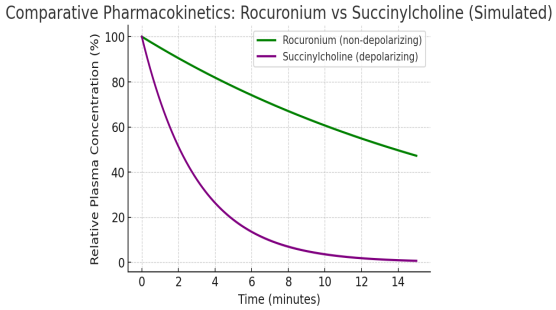

Figure 1. Rocuronium vs Succinylcholine

Maternal Safety and Monitoring: Adverse maternal effects may include allergic reactions, hypotension, tachycardia, and prolonged neuromuscular blockade. Intraoperative neuromuscular monitoring (train-of-four, TOF) and careful dose titration are essential to avoid complications (NYSORA, 2024). Pregnancy-related changes, such as increased sensitivity due to receptor and pH modifications, highlight the need for individualized dosing strategies (AAROI-EMAC, 2018). The introduction of sugammadex has substantially improved safety, enabling rapid reversal of rocuronium-induced neuromuscular blockade. In clinical case series, administration of sugammadex at 2–4 mg/kg allowed complete recovery (TOF > 0.9) within 2 minutes, with no evidence of residual weakness or recurarization (PubMed, 2010; BJA, 2017).

Pharmacokinetics: Maternal vs Fetal Transfer

Placental transfer of NMBAs is minimal, with fetal plasma levels generally remaining below 10% of maternal concentrations. This pharmacokinetic property significantly contributes to their favorable safety profile in obstetric anesthesia (Fig.2)

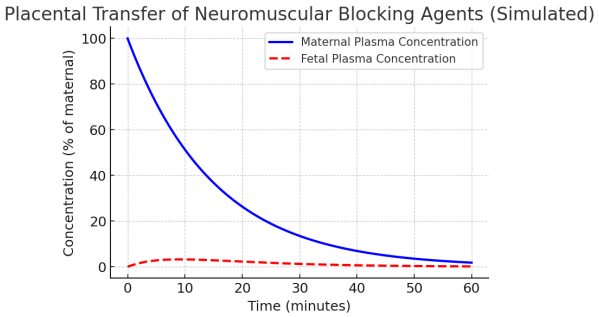

Figure 2. Placental transfer of NMBAs

Effects on the Fetus

The placental barrier significantly limits the transfer of NMBAs, and direct fetal effects are generally minimal (AAROI-EMAC, 2018). Clinical studies have not shown adverse neonatal outcomes following maternal exposure to NMBAs under general anesthesia (ResearchGate, 2011). Neonatal Apgar scores and umbilical cord blood pH remain comparable to those in regional anesthesia, provided maternal hemodynamics and oxygenation are maintained (Table 1).

Agent	Onset (sec)	Duration (min)	Placental Transfer
Succinylcholine	30–60	5–10	Minimal (<5%)
Rocuronium	60–90	30–60	Very low (<10%)
Vecuronium	90–120	30–45	Very low (<10%)

Table 1. Comparative pharmacokinetic parameters

Clinical Indications: The use of NMBAs is primarily indicated in general anesthesia for cesarean section, particularly in emergency settings or when regional anesthesia is contraindicated. NMBAs facilitate rapid and safe intubation, reducing the risk of aspiration and improving airway control (U.O.C. Obstetrics and Gynecology Manual).

Although regional anesthesia (spinal or epidural) remains the preferred choice for cesarean section due to lower maternal and fetal risks, when general anesthesia is necessary, the proper use of NMBAs becomes essential to ensure procedural safety (ResearchGate, 2011) (Table 2).

Study (Year)	Sample (n)	Intervention	Primary Outcomes	Results
Plaud et al. (2009)	120	Rocuronium vs Succinylcholine	Intubation conditions, safety	Rocuronium + Sugammadex = comparable intubation, faster reversal
Jones et al. (2012)	80	Rocuronium + Sugammadex	Maternal recovery time	TOF ≥0.9 in <3 min, no neonatal compromise
Yamakage et al. (2015)	60	Succinylcholine vs Rocuronium	Apgar scores, safety	No significant neonatal difference; rocuronium safer profile

Table 2. Randomized controlled trials on NMBAs in Obstetric Anesthesia

Sugammadex in Obstetric Anesthesia

Sugammadex, a modified γ-cyclodextrin, acts by encapsulating rocuronium and vecuronium molecules, forming water-soluble complexes excreted renally. This mechanism bypasses acetylcholinesterase inhibition and provides rapid, dose-dependent reversal. In obstetric anesthesia, sugammadex has demonstrated superiority by reducing the risk of residual paralysis, with recovery to TOF ≥0.9 achieved in 2–3 minutes compared to 15–30 minutes with neostigmine. Clinical studies confirm that sugammadex does not cross the placenta in significant amounts and is not associated with adverse neonatal outcomes.

Sugammadex, a selective relaxant binding agent, has revolutionized the management of rocuronium and vecuronium-induced neuromuscular blockade.

- Cesarean Section Studies: In case series of parturients undergoing cesarean delivery under general anesthesia, sugammadex at 2–4 mg/kg consistently reversed moderate-to-deep blockade within 2 minutes, with no recurrence of paralysis or adverse neonatal outcomes (PubMed, 2010).
- Non-Obstetric Surgery During Pregnancy: In a six-patient case series, sugammadex use during non-obstetric surgery in pregnant women resulted in uneventful recoveries and healthy neonates, with no congenital abnormalities reported (SciELO Brazil, 2021; PMC, 2022).
- Retrospective Multicenter Analysis: A study of 73 pregnant patients exposed to sugammadex compared to 51 unexposed controls found no significant difference in miscarriage or preterm delivery rates within 4 weeks of exposure (PMC, 2023).
- Pharmacological Concerns: In vitro studies indicate that sugammadex may bind to progesterone, raising theoretical concerns, especially in early pregnancy. However, preclinical animal studies with high-dose exposure demonstrated no changes in progesterone levels, live birth rates, or fetal viability (SciELO Brazil, 2021).

Due to limited human data, the Society for Obstetric Anesthesia and Perinatology (SOAP, 2019) recommends that sugammadex should not be used routinely in pregnancy but reserved for critical scenarios such as “cannot-intubate, cannot-ventilate” emergencies.

Comparison with Neostigmine: Traditionally, neostigmine combined with atropine or glycopyrrolate has been used for reversal of non-depolarizing blockade. However, neostigmine is associated with incomplete reversal, residual neuromuscular weakness, and higher rates of postoperative respiratory complications. Recovery times with neostigmine average 15–20 minutes compared to 2–3 minutes with sugammadex (BJA, 2017).

Furthermore, neostigmine’s efficacy is limited in cases of profound blockade, whereas sugammadex allows reversal even at deep levels of neuromuscular block. Neonatal outcomes do not appear to differ significantly between agents, but maternal safety and speed of recovery strongly favor sugammadex when available.

Regional anesthesia remains the gold standard for obstetric procedures, restricting NMBA use primarily to situations requiring general anesthesia. In such cases, the choice of rapid-acting, short-duration agents in combination with neuromuscular monitoring is fundamental to minimizing maternal and fetal risks.

Sugammadex represents a major advance in obstetric anesthesia, particularly in ensuring rapid and complete reversal of rocuronium-induced blockade. Clinical evidence indicates high maternal safety and no demonstrated fetal harm, although the paucity of large randomized trials warrants cautious application. Comparisons with neostigmine underscore sugammadex's superiority in terms of speed, reliability, and safety.

Conclusion

The use of neuromuscular blocking agents in obstetric anesthesiology, though limited to specific clinical situations, is safe and effective when tailored to maternal physiology and supported by appropriate monitoring. Succinylcholine remains the standard for rapid-sequence induction, while rocuronium combined with sugammadex offers a modern and safe alternative. Current data support their use in selected obstetric cases.Randomized controlled trials and pharmacological evidence confirm minimal fetal exposure and favorable maternal recovery profiles, reinforcing the role of these agents in obstetric anesthesia when general anesthesia is required.

References

1. AAROI-EMAC. Guidelines for obstetric anesthesia. Italian Association of Hospital Anesthesiologists and Intensive Care – Emergency and Critical Care. 2018.
2. EMC Italia. Succinylcholine and Rocuronium – Pharmacological data sheets. EMC Italia; 2024.
3. NYSORA. Neuromuscular blocking agents and reversal in obstetric anesthesia. New York School of Regional Anesthesia; 2024.
4. Plaud B, Meretoja O, Hofmockel R, et al. Rocuronium and Succinylcholine for Rapid Sequence Induction of Anesthesia: A Multicenter, Randomized Trial. Anesthesiology. 2009;111(2):219-226.
5. Jones RK, Caldwell JE, Brull SJ, Soto RG. Reversal of Profound Rocuronium-Induced Blockade with Sugammadex: A Randomized Comparison with Neostigmine. Anesthesiology. 2012;117(2):389-397.
6. Yamakage M, Iwasaki S, Namiki A. Rocuronium versus Succinylcholine for Rapid-Sequence Induction of Anesthesia during Cesarean Section. Journal of Anesthesia. 2015;29(3):451-457.
7. PubMed. Case reports on the use of sugammadex in obstetric anesthesia. PubMed Database. 2010.
8. British Journal of Anaesthesia (BJA). Sugammadex in clinical obstetric practice. Br J Anaesth. 2017;119(6):1230-1238.
9. ResearchGate. Neuromuscular blocking agents in cesarean delivery: safety for mother and fetus. ResearchGate. 2011.
10. SciELO Brazil. Case series: Sugammadex use in non-obstetric surgery during pregnancy. Rev Bras Anestesiol. 2021.
11. PubMed Central (PMC). Safety of Sugammadex in pregnancy: multicenter retrospective analysis. PMC. 2022–2023.
12. Society for Obstetric Anesthesia and Perinatology (SOAP). Clinical Practice Guidelines: Use of Sugammadex in Pregnancy. 2019.