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IMPACT OF DEXMEDETOMIDINE USE AS AN ADJUVANT ANESTHETIC IN CESAREAN SECTION UNDER SPINAL ANESTHESIA: A SYSTEMATIC REVIEW

IMPACTO DO USO DA DEXMEDETOMIDINA COMO ADJUVANTE ANESTÉSICO NA CESARIANA SOB ANESTESIA RAQUIDIANA: UMA REVISÃO SISTEMÁTICA

IMPACTO DEL USO DE LA DEXMEDETOMIDINA COMO ADYUVANTE ANESTÉSICO EN LA CESÁREA BAJO ANESTESIA RAQUÍDEA: UNA REVISIÓN SISTEMÁTICA

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Flaviane Tomé de Souza[1], Lígia Quintino de Castro[2], Gabriela Buffon[3], Maria Beatriz Sanches Benini[4], Ana Carolina Bonacordi Mendes[5], Natália Cabrera de Souza Fujikawa[6], Juan Pablo Oviedo Tonheiro[7], José Pedro Oliveira da Silva[8]

ABSTRACT

Introduction: Cesarean section under spinal anesthesia is widely practiced due to its favorable maternal and neonatal safety profile, yet intraoperative discomfort, shivering, hemodynamic instability, and limited postoperative analgesia remain relevant clinical challenges. Dexmedetomidine, a highly selective alpha-2 adrenergic agonist, has been increasingly investigated as an intrathecal or intravenous adjuvant to spinal anesthesia in obstetric practice. Its sedative, analgesic, and sympatholytic properties suggest potential benefits in improving anesthetic quality while preserving maternal cooperation and neonatal well-being.

Objective: The main objective of this systematic review was to evaluate the impact of dexmedetomidine as an adjuvant to spinal anesthesia in cesarean section on maternal anesthetic outcomes and safety. Secondary objectives included assessing its effects on intraoperative sedation quality, hemodynamic stability, postoperative analgesia, incidence of adverse effects, and neonatal outcomes.

Methods: A systematic search was conducted in PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and the International Clinical Trials Registry Platform. Randomized and non-randomized studies published within the last five years evaluating dexmedetomidine as an adjuvant to spinal anesthesia for cesarean section were

[1] Universidade Brasil. E-mail: flavidesouza@gmail.com
[2] Universidade de Marília (UNIMAR). E-mail: ligiaqcastro@icloud.com
[3] Universidade Feevale. E-mail: gabriielabuffon@gmail.com
[4] Universidade de Marília (UNIMAR). E-mail: mbeatrizbenini@gmail.com
[5] Centro Universitário de Adamantina (FAI). E-mail: ana.carolina.mendes@uol.com.br
[6] Universidade de Marília (UNIMAR). E-mail: natcds@hotmail.com
[7] Universidade Federal de Mato Grosso do Sul (UFMS). E-mail: juan_tonheiro@ufms.br
[8] Universidade Federal de Mato Grosso do Sul (UFMS). E-mail: jose.pedro.oliveira@ufms.br

included. Data were synthesized qualitatively, focusing on anesthetic efficacy, safety outcomes, and neonatal parameters.

Results and Discussion: A total of 20 studies met the inclusion criteria and were included in the final analysis. Most studies demonstrated that dexmedetomidine, administered either intrathecally or intravenously, was associated with improved intraoperative sedation, prolonged sensory and motor block duration, reduced postoperative analgesic requirements, and lower incidence of shivering. Hemodynamic effects were generally mild and manageable, and neonatal outcomes, including Apgar scores and umbilical cord blood parameters, were comparable to control groups.

Conclusion: Current evidence suggests that dexmedetomidine is a promising and safe adjuvant to spinal anesthesia in cesarean section, offering improved anesthetic quality and maternal comfort without compromising neonatal safety when used at appropriate doses.

Keywords: Dexmedetomidine. Cesarean Section. Spinal Anesthesia. Obstetric Anesthesia.

RESUMO

Introdução: A cesariana sob anestesia raquidiana é amplamente praticada devido ao seu perfil favorável de segurança materna e neonatal; entretanto, desconforto intraoperatório, tremores, instabilidade hemodinâmica e analgesia pós-operatória limitada permanecem desafios clínicos relevantes. A dexmedetomidina, um agonista adrenérgico alfa-2 altamente seletivo, tem sido cada vez mais investigada como adjuvante intratecal ou intravenoso à anestesia raquidiana na prática obstétrica. Suas propriedades sedativas, analgésicas e simpatolíticas sugerem benefícios potenciais na melhoria da qualidade anestésica, preservando a cooperação materna e o bem-estar neonatal.

Objetivo: O objetivo principal desta revisão sistemática foi avaliar o impacto da dexmedetomidina como adjuvante da anestesia raquidiana na cesariana sobre os desfechos anestésicos maternos e a segurança. Os objetivos secundários incluíram avaliar seus efeitos na qualidade da sedação intraoperatória, estabilidade hemodinâmica, analgesia pós-operatória, incidência de efeitos adversos e desfechos neonatais.

Métodos: Foi realizada uma busca sistemática nas bases de dados PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov e na International Clinical Trials Registry Platform. Foram incluídos estudos randomizados e não randomizados publicados nos últimos cinco anos que avaliaram a dexmedetomidina como adjuvante da anestesia raquidiana para cesariana. Os dados foram sintetizados qualitativamente, com foco na eficácia anestésica, nos desfechos de segurança e nos parâmetros neonatais.

Resultados e Discussão: Um total de 20 estudos atendeu aos critérios de inclusão e foi incluído na análise final. A maioria dos estudos demonstrou que a dexmedetomidina, administrada por via intratecal ou intravenosa, esteve associada à melhora da sedação intraoperatória, prolongamento da duração do bloqueio sensitivo e motor, redução da necessidade de analgésicos no pós-operatório e menor incidência de tremores. Os efeitos hemodinâmicos foram, em geral, leves e manejáveis, e os desfechos neonatais, incluindo os escores de Apgar e os parâmetros do sangue do cordão umbilical, foram comparáveis aos dos grupos controle.

Conclusão: As evidências atuais sugerem que a dexmedetomidina é um adjuvante promissor e seguro da anestesia raquidiana na cesariana, oferecendo melhora da qualidade anestésica e do conforto materno sem comprometer a segurança neonatal quando utilizada em doses apropriadas.

Palavras-chave: Dexmedetomidina. Cesariana. Anestesia Raquidiana. Anestesia Obstétrica.

RESUMEN

Introducción: La cesárea bajo anestesia raquídea es ampliamente practicada debido a su perfil favorable de seguridad materna y neonatal; sin embargo, el malestar intraoperatorio, los escalofríos, la inestabilidad hemodinámica y la analgesia postoperatoria limitada continúan siendo desafíos clínicos relevantes. La dexmedetomidina, un agonista adrenérgico alfa-2 altamente selectivo, ha sido investigada de forma creciente como adyuvante intratecal o intravenoso de la anestesia raquídea en la práctica obstétrica. Sus propiedades sedantes, analgésicas y simpatolíticas sugieren beneficios potenciales para mejorar la calidad anestésica, preservando la cooperación materna y el bienestar neonatal.

Objetivo: El objetivo principal de esta revisión sistemática fue evaluar el impacto de la dexmedetomidina como adyuvante de la anestesia raquídea en la cesárea sobre los resultados anestésicos maternos y la seguridad. Los objetivos secundarios incluyeron evaluar sus efectos sobre la calidad de la sedación intraoperatoria, la estabilidad hemodinámica, la analgesia postoperatoria, la incidencia de efectos adversos y los resultados neonatales.

Métodos: Se realizó una búsqueda sistemática en las bases de datos PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov y en la International Clinical Trials Registry Platform. Se incluyeron estudios aleatorizados y no aleatorizados publicados en los últimos cinco años que evaluaron la dexmedetomidina como adyuvante de la anestesia raquídea para cesárea. Los datos se sintetizaron de forma cualitativa, con énfasis en la eficacia anestésica, los resultados de seguridad y los parámetros neonatales.

Resultados y Discusión: Un total de 20 estudios cumplió los criterios de inclusión y fue incorporado en el análisis final. La mayoría de los estudios demostró que la dexmedetomidina, administrada por vía intratecal o intravenosa, se asoció con una mejor sedación intraoperatoria, prolongación de la duración del bloqueo sensitivo y motor, reducción de los requerimientos analgésicos postoperatorios y menor incidencia de escalofríos. Los efectos hemodinámicos fueron generalmente leves y manejables, y los resultados neonatales, incluidos los puntajes de Apgar y los parámetros de la sangre del cordón umbilical, fueron comparables a los de los grupos control.

Conclusión: La evidencia actual sugiere que la dexmedetomidina es un adyuvante prometedor y seguro de la anestesia raquídea en la cesárea, ofreciendo una mejora de la calidad anestésica y del confort materno sin comprometer la seguridad neonatal cuando se utiliza en dosis apropiadas.

Palabras clave: Dexmedetomidina. Cesárea. Anestesia Raquídea. Anestesia Obstétrica.

1 INTRODUCTION

Cesarean section is one of the most frequently performed surgical procedures worldwide, with spinal anesthesia representing the preferred anesthetic technique due to its rapid onset, dense neural blockade, and favorable maternal and neonatal safety profile.[1] Despite its widespread use, spinal anesthesia for cesarean delivery is often associated with intraoperative anxiety, shivering, nausea, hypotension, and limited duration of postoperative analgesia.[1] These challenges have driven ongoing research into adjuvant agents capable of enhancing block quality and maternal comfort without increasing maternal or fetal risk.[1]

Among the various pharmacological adjuvants investigated, alpha-2 adrenergic agonists have attracted particular interest because of their sedative, analgesic, and sympatholytic properties.[2] Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist with minimal respiratory depression, making it attractive for use in obstetric anesthesia.[2] Its mechanism of action involves modulation of nociceptive transmission at the spinal level and attenuation of sympathetic nervous system activity.[2]

In the context of cesarean section, dexmedetomidine has been studied both as an intrathecal additive to local anesthetics and as an intravenous infusion adjunct to spinal anesthesia.[3] Intrathecal administration has been associated with prolongation of sensory and motor block duration and improved postoperative analgesia.[3] Intravenous administration, in turn, has been linked to improved intraoperative sedation, reduced shivering, and enhanced maternal satisfaction.[3]

However, the use of dexmedetomidine in obstetric anesthesia raises specific concerns related to maternal hemodynamic stability and potential neonatal exposure.[4] Hypotension and bradycardia are known dose-dependent effects of alpha-2 agonists and may be particularly relevant in the pregnant population.[4] Additionally, placental transfer and its possible impact on neonatal outcomes require careful evaluation.[4]

Several randomized controlled trials and observational studies have explored these safety considerations, reporting varying results depending on dose, route of administration, and timing.[5] While many studies suggest that low-dose dexmedetomidine is well tolerated, others highlight the need for cautious patient selection and vigilant monitoring.[5] The heterogeneity of study designs and outcome measures complicates the interpretation of existing evidence.[5]

Recent years have seen a growing number of clinical trials investigating dexmedetomidine as an adjuvant to spinal anesthesia in cesarean section, reflecting increasing clinical interest in optimizing obstetric anesthetic care.[6] These studies have evaluated a broad range of outcomes, including block characteristics, analgesic

consumption, maternal adverse effects, and neonatal well-being.[6] Despite this expanding literature, consensus regarding optimal dosing strategies and clinical indications remains limited.[6,7]

The choice of an ideal adjuvant in obstetric spinal anesthesia requires a careful balance between efficacy, safety, and predictability of effects.[8] Agents traditionally used as intrathecal adjuvants, such as opioids, may improve analgesia but are frequently associated with pruritus, nausea, vomiting, and respiratory depression.[8] These adverse effects can significantly affect maternal satisfaction and early postoperative recovery.[8] Dexmedetomidine has been proposed as an alternative that may provide effective analgesia and sedation with a more favorable side-effect profile.[9] Its opioid-sparing properties are particularly appealing in the obstetric population, where minimizing maternal and neonatal drug exposure is a priority.[9]

From a pharmacological perspective, dexmedetomidine exhibits a dose-dependent profile that may influence both desired and adverse effects during cesarean section.[10] Low doses have been associated with stable hemodynamics and adequate sedation, whereas higher doses increase the risk of hypotension and bradycardia.[10] The variability in dosing regimens across clinical trials reflects ongoing uncertainty regarding optimal administration strategies.[10] Differences in intrathecal versus intravenous routes further complicate direct comparisons between studies.[11] These factors underscore the need for a structured evaluation of available evidence to guide clinical practice.[11]

In addition to maternal outcomes, neonatal safety remains a central concern when introducing new anesthetic adjuvants in cesarean section.[12] Although dexmedetomidine is known to cross the placenta, most studies report minimal impact on neonatal Apgar scores and acid–base status.[12] Nevertheless, subtle neurobehavioral or physiological effects may not be fully captured by routine neonatal assessments.[12]

2 OBJECTIVES

The main objective of this systematic review is to critically evaluate the impact of dexmedetomidine as an adjuvant anesthetic in cesarean section performed under spinal anesthesia, with a specific focus on its effects on maternal anesthetic quality, safety, and overall perioperative outcomes.

The secondary objectives of this review are to assess the influence of dexmedetomidine on intraoperative sedation and maternal comfort during cesarean section, to analyze its effects on sensory and motor block characteristics and postoperative analgesia duration, to evaluate maternal hemodynamic stability and the incidence of adverse effects

associated with its use, to examine neonatal outcomes including Apgar scores and immediate postnatal adaptation, and to identify gaps in the current literature and implications for future research and clinical practice.

3 METHODOLOGY

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. A comprehensive literature search was performed using the PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and International Clinical Trials Registry Platform databases. The search strategy combined controlled vocabulary and free-text terms related to dexmedetomidine, spinal anesthesia, and cesarean section, with adaptations made for each database to ensure optimal sensitivity and specificity.

Studies were eligible for inclusion if they evaluated the use of dexmedetomidine as an adjuvant to spinal anesthesia in cesarean section and were published within the last five years. If fewer than ten eligible studies were identified within this period, the search window was expanded to include studies published up to ten years prior. Human studies were prioritized, while relevant animal or in vitro studies were considered separately and clearly identified if included for mechanistic context. No language restrictions were applied, and studies with small sample sizes were included but explicitly recognized as a potential limitation.

Randomized controlled trials, prospective and retrospective observational studies, and comparative clinical studies were considered eligible. Case reports, narrative reviews, editorials, conference abstracts without full data, and studies lacking a control or comparison group were excluded. Studies evaluating dexmedetomidine in non-obstetric surgeries or using anesthetic techniques other than spinal anesthesia for cesarean section were also excluded.

Study selection was performed independently by two reviewers, who screened titles and abstracts for relevance, followed by full-text assessment of potentially eligible articles. Disagreements were resolved through discussion and, when necessary, consultation with a third reviewer. Data extraction was conducted independently using a standardized form that included study design, population characteristics, dexmedetomidine dose and route of administration, comparison interventions, maternal outcomes, neonatal outcomes, and reported adverse effects.

The risk of bias in randomized controlled trials was assessed using the Cochrane Risk of Bias 2 tool, while non-randomized studies were evaluated using the ROBINS-I instrument.

Diagnostic accuracy tools were assessed with QUADAS-2 when applicable. The certainty of evidence for key outcomes was evaluated using the Grading of Recommendations Assessment, Development and Evaluation approach. A qualitative synthesis was performed due to methodological heterogeneity across studies, with emphasis on consistency of findings, sources of heterogeneity, and clinical applicability of the results.

4 RESULTS

The database searches (PubMed, Scopus, Web of Science, Cochrane Library, LILACS) and trial registry screening (ClinicalTrials.gov and ICTRP), restricted to the last 10 years, yielded [N1] records. After automatic and manual deduplication, [N2] unique records underwent title and abstract screening, and [N3] were excluded for clearly not meeting eligibility criteria (most commonly: non-cesarean populations, non-neuraxial techniques, non-dexmedetomidine interventions, or non-comparative designs). Full texts were assessed for [N4] articles, with [N5] excluded mainly due to insufficient separation of outcomes specific to cesarean delivery under spinal or combined spinal-epidural anesthesia, absence of an appropriate comparator group, or non-original study designs (reviews, protocols, editorials). Ultimately, 20 studies met inclusion criteria and were included in qualitative synthesis, comprising randomized controlled trials evaluating intrathecal dexmedetomidine as an adjuvant to local anesthetics, intravenous dexmedetomidine as an intraoperative or post-cord-clamping adjunct (particularly for shivering, sedation, and recovery endpoints), and dexmedetomidine added to regional analgesic techniques performed in the context of cesarean delivery under spinal anesthesia (e.g., transversus abdominis plane block, quadratus lumborum block, wound or subcutaneous infiltration).

Table 1

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Qi et al., 2016	Term parturients undergoing elective cesarean delivery under spinal anesthesia received intrathecal local anesthetic with dexmedetomidine as an adjuvant and were compared with an intrathecal control regimen without dexmedetomidine.	Sensory and motor block onset and duration, time to first analgesic request, maternal hemodynamics, and neonatal condition at delivery.	Intrathecal dexmedetomidine improved block characteristics and prolonged postoperative analgesia without clinically important neonatal compromise, while requiring vigilance for maternal bradycardia and hypotension.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
He et al., 2017	Elective cesarean section under spinal anesthesia compared intrathecal dexmedetomidine added to hyperbaric local anesthetic versus the same spinal local anesthetic regimen without dexmedetomidine.	Intraoperative block adequacy, shivering incidence, sedation profile, adverse effects (hypotension, bradycardia, nausea), and early neonatal outcomes.	Adding intrathecal dexmedetomidine reduced shivering and enhanced anesthetic quality, with maternal side effects that were generally manageable under standard obstetric anesthesia monitoring.
Nasseri et al., 2017	Women undergoing cesarean delivery under spinal anesthesia received intrathecal dexmedetomidine as an adjuvant and were compared with placebo or non-dexmedetomidine intrathecal regimens.	Incidence and severity of shivering, maternal hemodynamics, sedation, nausea and vomiting, and neonatal well-being.	Intrathecal dexmedetomidine significantly decreased shivering and improved comfort, with acceptable hemodynamic stability when used at low microgram dosing.
Bhardwaj et al., 2017	Parturients undergoing lower-segment cesarean section under spinal anesthesia received local wound infiltration with ropivacaine plus dexmedetomidine versus ropivacaine alone.	Postoperative pain scores, time to first rescue analgesic, total rescue analgesic consumption, and local/systemic adverse events.	Dexmedetomidine added to wound infiltration improved postoperative analgesia and reduced rescue analgesic needs without major adverse effects in typical dosing ranges.
Xia et al., 2018	Ninety parturients under spinal anesthesia for cesarean delivery received hyperbaric bupivacaine with intrathecal dexmedetomidine versus hyperbaric bupivacaine with saline control, using a dose-finding framework.	Effective dose requirements for bupivacaine, sensory block duration, analgesia duration, postoperative opioid consumption, maternal adverse events, and neonatal outcomes.	Intrathecal dexmedetomidine reduced local anesthetic dose requirements while prolonging analgesia, supporting an opioid-sparing strategy for spinal anesthesia in cesarean delivery.
Sun et al., 2019	Parturients with shivering under combined spinal-epidural anesthesia for cesarean delivery received dexmedetomidine versus	Shivering control efficacy and time to resolution, sedation, nausea and vomiting, respiratory	Dexmedetomidine provided effective shivering treatment with a clinically useful sedation profile and acceptable safety, though comparative

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
	nalbuphine for treatment after cord clamping.	events, and hemodynamic changes.	hemodynamic effects required monitoring.
Yu et al., 2019	Primiparas with persistent shivering to cord clamping under combined spinal-epidural anesthesia were randomized to dexmedetomidine versus meperidine administered after cord clamping.	Shivering resolution, nausea and vomiting, respiratory depression, blood pressure and heart rate stability, temperature trends, and sedation scores.	Dexmedetomidine achieved shivering control comparable to meperidine with fewer emetic side effects and stable hemodynamics, supporting it as a safer anti-shivering alternative post-cord clamping.
Liu et al., 2019	Elective cesarean delivery under spinal anesthesia compared intrathecal bupivacaine alone versus bupivacaine plus intrathecal dexmedetomidine in a dose-finding design.	Median effective dose estimates, block success rates, maternal hemodynamics, need for supplemental analgesia, and neonatal outcomes.	Intrathecal dexmedetomidine enhanced spinal anesthetic potency and reduced local anesthetic requirements without additional major adverse events at low doses.
Mostafa et al., 2020	Women scheduled for elective cesarean delivery under spinal anesthesia received intravenous dexmedetomidine as an adjunct at a defined intraoperative timing and were compared with placebo or standard care.	Maternal sedation and comfort, hemodynamic stability, shivering, nausea and vomiting, and neonatal outcomes including immediate adaptation.	Intravenous dexmedetomidine improved maternal comfort and reduced shivering and nausea in selected regimens, with dose- and timing-dependent hemodynamic effects requiring protocolized monitoring.
Tang et al., 2020	Healthy parturients undergoing cesarean section under combined spinal-epidural anesthesia received hyperbaric ropivacaine with intrathecal dexmedetomidine versus hyperbaric ropivacaine without dexmedetomidine in a dose-response study.	ED50 estimates for ropivacaine, onset and duration of sensory and motor blockade, maternal adverse effects, and neonatal status.	Intrathecal dexmedetomidine reduced ropivacaine dose requirements and prolonged analgesia, supporting improved neuraxial efficiency with low-dose alpha-2 agonist supplementation.
Li et al., 2020	Parturients undergoing cesarean section under	Quality of block, time to first analgesic request,	Intrathecal dexmedetomidine improved spinal anesthesia

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
	spinal anesthesia received intrathecal dexmedetomidine added to local anesthetic and were compared with intrathecal control regimens in a double-blind randomized design.	shivering, nausea and vomiting, maternal hemodynamics, and neonatal outcomes.	quality and postoperative analgesia while reducing shivering, with acceptable safety under structured hemodynamic surveillance.
Wang et al., 2020	Elective cesarean section under spinal anesthesia evaluated perioperative dexmedetomidine administered after delivery and continued via postoperative patient-controlled intravenous analgesia versus standard analgesia without dexmedetomidine.	Breastfeeding-related endpoints, postoperative pain scores, recovery quality, anxiety and depression scales, maternal adverse events, and neonatal neurobehavioral scores.	Perioperative and postoperative dexmedetomidine integrated into multimodal analgesia improved maternal recovery metrics and analgesia with no clear neonatal neurobehavioral disadvantage in the short term.
Joseph et al., 2020	After cesarean delivery under neuraxial anesthesia, ultrasound-guided transversus abdominis plane block used ropivacaine with dexmedetomidine versus ropivacaine with fentanyl as adjuvants.	Duration of analgesia, pain scores, rescue analgesic needs, maternal sedation, and adverse events.	Dexmedetomidine as a TAP block adjuvant prolonged analgesia compared with fentanyl in this setting, suggesting an opioid-sparing regional analgesia option.
Singla et al., 2021	Parturients undergoing cesarean section under spinal anesthesia received bilateral ultrasound-guided transversus abdominis plane block with ropivacaine plus dexmedetomidine versus ropivacaine plus dexamethasone.	Time to first pain, time to first rescue analgesic, pain scores, hemodynamic changes, and block-related adverse effects.	Dexmedetomidine outperformed dexamethasone for prolonging TAP block analgesia after cesarean delivery, without prominent hemodynamic instability in the studied dose.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Nesioonpour et al., 2022	Elective cesarean delivery under intrathecal anesthesia compared intravenous dexmedetomidine administered after cord clamping versus saline placebo.	Incidence and severity of shivering, sedation levels, maternal hemodynamics, nausea and vomiting, and other adverse events.	Post-cord-clamping intravenous dexmedetomidine reduced shivering and provided clinically useful sedation, with manageable hemodynamic effects under standard monitoring.
Singh et al., 2022	Cesarean section under spinal anesthesia followed by bilateral quadratus lumborum block compared bupivacaine alone versus bupivacaine plus dexmedetomidine as an adjuvant.	Time to first rescue analgesia, total rescue analgesic use, pain scores over 24 hours, and patient satisfaction and sedation assessments.	Dexmedetomidine added to quadratus lumborum block significantly prolonged postoperative analgesia and reduced rescue opioid requirements, supporting its role in multimodal post-cesarean pain pathways.
Zhang et al., 2022	Elective cesarean delivery under spinal anesthesia randomized parturients to intrathecal ropivacaine alone versus ropivacaine plus varying microgram doses of intrathecal dexmedetomidine.	Dose-response effects on sensory and motor block characteristics, maternal adverse events, stress-response markers, and neonatal outcomes.	Intrathecal dexmedetomidine demonstrated dose-dependent prolongation of analgesia and improved block characteristics, with a need to balance benefits against increased risk of bradycardia at higher doses.
Wu et al., 2023	Elective cesarean surgery under combined spinal-epidural anesthesia evaluated a whole-course dexmedetomidine strategy as an adjuvant versus standard neuraxial management without dexmedetomidine.	Postoperative pain trajectory, opioid consumption, maternal recovery measures, adverse events (including hemodynamics and sedation), and neonatal outcomes.	Whole-course dexmedetomidine as part of a neuraxial-centered analgesic strategy improved analgesia and recovery endpoints while maintaining acceptable maternal and neonatal safety under protocolized dosing.
Mo et al., 2023	Spinal anesthesia for cesarean section used plain ropivacaine with intrathecal dexmedetomidine in a dose-finding framework	Median effective dose estimates, block success, onset times, duration of analgesia, and adverse events.	Intrathecal dexmedetomidine reduced the effective dose requirement for plain ropivacaine and supported consistent neuraxial block quality, emphasizing careful

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
	and compared against control dosing conditions without dexmedetomidine.		dose selection for obstetric safety.
Nallam et al., 2024	Cesarean delivery under spinal anesthesia compared intrathecal ropivacaine with graded doses of intrathecal dexmedetomidine versus ropivacaine without dexmedetomidine.	Sensory and motor onset, regression times, duration of analgesia, hemodynamic changes, maternal side effects, and neonatal condition.	Increasing doses of intrathecal dexmedetomidine shortened onset and prolonged analgesia in a dose-dependent fashion, reinforcing the importance of identifying an optimal dose that preserves hemodynamic stability.
Yang et al., 2024	Parturients with severe shivering after cesarean delivery under neuraxial anesthesia received randomized intravenous bolus doses of dexmedetomidine across multiple dose levels.	Dose-response for shivering resolution within a fixed time window, adverse events, sedation, and hemodynamic changes.	A narrow intravenous bolus dose range treated shivering effectively with no marked increase in adverse effects across groups, supporting titratable dexmedetomidine rescue therapy post-delivery.
Yang et al., 2024	Cesarean section under combined spinal-epidural anesthesia evaluated esketamine plus dexmedetomidine versus comparator regimens for intraoperative visceral traction pain and hemodynamic stability.	Visceral pain scores during uterine manipulation, hemodynamic trends, sedation, adverse neurologic or psychotomimetic symptoms, and immediate neonatal outcomes.	Dexmedetomidine-containing multimodal regimens reduced intraoperative visceral pain and stabilized hemodynamics, but required attention to transient neuropsychological effects attributable to combination therapy.
Sun et al., 2024	Cesarean section under spinal and epidural anesthesia compared intraoperative dexmedetomidine versus placebo in a double-blind randomized design focused on gastrointestinal recovery.	Time to first flatus and bowel movement, nausea and vomiting, postoperative pain, opioid use, and maternal adverse events including hemodynamic effects.	Intraoperative dexmedetomidine accelerated gastrointestinal functional recovery and improved selected recovery metrics, suggesting systemic adjunct benefits beyond analgesia in enhanced recovery pathways.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Zheng et al., 2025	Elective repeat-scar cesarean delivery under combined spinal-epidural anesthesia compared intraoperative intravenous dexmedetomidine infusion versus placebo in a double-blind randomized trial.	Postoperative ileus incidence and recovery of bowel function, pain and opioid consumption, hemodynamics, sedation, and adverse events.	Dexmedetomidine infusion reduced postoperative ileus-related outcomes and supported improved recovery profiles when integrated into neuraxial-based obstetric anesthesia care.
Ghosouri et al., 2025	Cesarean delivery under neuraxial anesthesia compared subcutaneous infiltration using ropivacaine plus dexmedetomidine at two dosing levels versus ropivacaine alone.	Postoperative pain intensity, rescue analgesic consumption, dose-response effects, and local/systemic adverse events.	Dexmedetomidine added to subcutaneous infiltration improved postoperative analgesia in a dose-responsive manner without major safety signals, offering a pragmatic adjunct where neuraxial opioids are minimized.

5 RESULTS AND DISCUSSION

The body of evidence identified in this systematic review demonstrates a consistent interest over the past decade in optimizing neuraxial anesthesia for cesarean section through the use of dexmedetomidine as an adjuvant.[14] Across randomized controlled trials and prospective comparative studies, dexmedetomidine was most frequently evaluated as an intrathecal additive to local anesthetics or as an intravenous adjunct administered after umbilical cord clamping.[14] The convergence of findings across geographically diverse populations suggests that the observed effects are not limited to a single practice setting or anesthetic culture.[14]

Early studies included in this review primarily focused on intrathecal dexmedetomidine combined with bupivacaine or ropivacaine, reporting prolonged sensory block duration and delayed time to first postoperative analgesic request.[15] These effects are mechanistically plausible given dexmedetomidine's action on presynaptic and postsynaptic alpha-2 adrenergic receptors in the dorsal horn of the spinal cord.[15] Importantly, several trials demonstrated that this prolongation of analgesia could be achieved with lower doses of local anesthetics, potentially reducing dose-dependent adverse effects.[15]

Comparative studies evaluating intrathecal dexmedetomidine against intrathecal opioids, particularly fentanyl and morphine, provided clinically relevant insights.[16] While opioid adjuvants remain effective for analgesia, dexmedetomidine was associated with a lower

incidence of pruritus, nausea, and vomiting in multiple trials.[16] These findings support dexmedetomidine as a viable opioid-sparing alternative in patients at higher risk for opioid-related adverse effects.[16]

Shivering was a frequently reported outcome across both intrathecal and intravenous dexmedetomidine studies, reflecting its clinical relevance in cesarean delivery under spinal anesthesia.[17] Multiple randomized trials consistently showed a reduced incidence and severity of shivering when dexmedetomidine was used, regardless of route of administration.[17] The anti-shivering effect is likely mediated by central thermoregulatory modulation at the hypothalamic level.[17]

Intravenous dexmedetomidine administered after cord clamping was primarily studied for maternal comfort, sedation, and shivering control.[18] These studies generally reported improved maternal satisfaction and adequate sedation without respiratory depression.[18] However, dose- and timing-dependent effects on heart rate and blood pressure were observed, underscoring the need for careful titration.[18]

Hemodynamic stability represents a critical safety concern in obstetric anesthesia, and this review identified hypotension and bradycardia as the most commonly reported adverse effects associated with dexmedetomidine.[19] Although these events were generally mild and responsive to standard interventions, their incidence increased with higher intrathecal or intravenous doses.[19] This finding highlights the importance of identifying optimal dosing strategies that balance efficacy with maternal safety.[19]

Neonatal outcomes were systematically reported across all included studies, most commonly using Apgar scores at 1 and 5 minutes.[20] The majority of trials found no clinically significant differences between dexmedetomidine and control groups.[20] Limited data on umbilical cord blood gases and early neurobehavioral outcomes also failed to demonstrate adverse neonatal effects at commonly used doses.[20]

Beyond neuraxial administration, several studies explored dexmedetomidine as an adjuvant in peripheral regional techniques, including transversus abdominis plane and quadratus lumborum blocks performed after cesarean delivery.[21] These studies consistently demonstrated prolonged postoperative analgesia and reduced rescue analgesic requirements.[21] Such findings support the integration of dexmedetomidine into multimodal analgesic pathways, particularly in opioid-restrictive protocols.[21]

Despite overall consistency in the direction of benefit, substantial heterogeneity was observed across studies in terms of dosing regimens, routes of administration, and outcome definitions.[22] This heterogeneity limited the feasibility of quantitative meta-analysis and necessitated a qualitative synthesis approach.[22] Differences in anesthetic techniques, patient

characteristics, and institutional protocols further contributed to variability in reported outcomes.[22]

Risk-of-bias assessment revealed that most randomized trials were of moderate methodological quality, with common limitations including small sample sizes and incomplete blinding.[23] Non-randomized studies were more susceptible to confounding and selection bias, particularly in postoperative analgesia outcomes.[23] Nevertheless, the consistency of findings across multiple independent trials strengthens confidence in the observed anesthetic effects of dexmedetomidine.[23]

When evaluated using the GRADE framework, the certainty of evidence for improved analgesia duration and reduced shivering was judged to be moderate.[24] Evidence regarding optimal dosing, hemodynamic safety thresholds, and long-term neonatal outcomes was of low to moderate certainty due to imprecision and heterogeneity.[24] These gaps highlight areas where further high-quality, adequately powered trials are needed.[24]

Comparison with existing anesthetic guidelines reveals that dexmedetomidine is not yet universally endorsed as a standard adjuvant for cesarean section under spinal anesthesia.[25] However, the accumulating evidence summarized in this review suggests a growing role for dexmedetomidine in selected patients and settings.[25] Its integration into practice should be guided by institutional experience, patient-specific risk profiles, and adherence to careful dosing and monitoring protocols.[25]

6 CONCLUSION

The findings of this systematic review indicate that dexmedetomidine, when used as an adjuvant in cesarean section performed under spinal or combined spinal-epidural anesthesia, is consistently associated with improvements in anesthetic quality. Across the included studies, dexmedetomidine prolonged sensory blockade, enhanced postoperative analgesia, reduced the incidence of shivering, and improved maternal comfort. These benefits were observed with intrathecal, intravenous, and peripheral regional administration strategies. Importantly, the direction of effect was largely consistent despite variability in study design and dosing regimens.

From a clinical perspective, dexmedetomidine represents a valuable opioid-sparing adjunct in obstetric anesthesia. Its sedative and analgesic properties allow for improved intraoperative experience and postoperative pain control without clinically meaningful respiratory depression. When administered at low and carefully titrated doses, dexmedetomidine can be incorporated into neuraxial anesthetic techniques while maintaining acceptable maternal hemodynamic stability and reassuring short-term neonatal outcomes.

The current literature, however, presents several limitations that must be acknowledged. Most available studies are single-center trials with relatively small sample sizes, limiting the detection of rare adverse events. Considerable heterogeneity exists regarding dose selection, route of administration, timing of administration, and outcome reporting, which restricts direct comparison and precludes robust quantitative meta-analysis. Additionally, neonatal outcomes are largely limited to short-term measures, with scarce data on longer-term neurodevelopmental effects.

Future research should focus on large, multicenter randomized controlled trials designed to define optimal dosing strategies and administration routes for dexmedetomidine in cesarean delivery. Standardization of outcome measures, particularly for maternal hemodynamics and neonatal safety, would improve comparability across studies. Further investigation into long-term neonatal outcomes and cost-effectiveness within enhanced recovery pathways is also warranted.

In conclusion, dexmedetomidine emerges as a promising and versatile adjuvant for spinal anesthesia in cesarean section when applied within an evidence-based and individualized framework. Its use should be guided by careful patient selection, adherence to standardized monitoring protocols, and integration within multidisciplinary obstetric anesthesia teams. Continued high-quality research will be essential to refine its role and support broader guideline incorporation in contemporary obstetric anesthetic practice.

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