E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/16.01.547

Research Article

BEYOND THE BLOCK: INTRAVENOUS MAGNESIUM SULPHATE VS. DEXAMETHASONE FOR POSTOPERATIVE ANALGESIA FOLLOWING CESAREAN SECTION UNDER SPINAL ANAESTHESIA

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ABSTRACT

Background: Spinal anaesthesia is the workhorse of obstetric practice — rapid, reliable, and cost-effective — yet its Achilles heel lies in its brevity. Once the block fades, patients face a familiar adversary: breakthrough pain that demands escalating opioids, delays mobilization, and compromises early recovery. Pharmacological adjuvants have emerged as a promising strategy to extend analgesia and bridge this postoperative gap. Despite individual evidence supporting both intravenous magnesium sulphate and dexamethasone as pre-emptive analgesics, head-to-head data comparing their efficacy in the context of cesarean section under spinal anaesthesia remain scarce.

Methods: Following institutional ethics approval, this prospective randomized trial enrolled 62 parturients (31 per group) scheduled for elective cesarean section under spinal anaesthesia. Group A received a preoperative infusion of magnesium sulphate (50 mg/kg) and Group B received dexamethasone (8 mg), each diluted in 100 mL of 0.9% saline. Primary outcomes included duration of sensory and motor block, Visual Analogue Scale (VAS) pain scores over 24 hours, time to first rescue analgesia, and total analgesic consumption.

Results: Magnesium sulphate decisively outperformed dexamethasone across all analgesic endpoints. The duration of sensory block was significantly prolonged in Group A (172.9 ± 6.58 min) compared to Group B (143.16 ± 8.62 min; $p<0.0001$), as was motor block (162.65 ± 6.13 min vs. 134.16 ± 8.13 min; $p<0.0001$). VAS pain scores were significantly lower in the magnesium group at 4, 8, 12, 18, and 24 hours postoperatively ($p<0.05$). The time to first rescue analgesia was markedly extended in Group A (270.67 ± 67.97 min vs. 223.33 ± 60.22 min; $p<0.0001$), and the total number of rescue analgesic doses within 24 hours was significantly reduced. Dexamethasone, however, conferred a notable advantage in reducing postoperative shivering (16.13% vs. 54.84%; $p=0.001$) and nausea/vomiting.

Conclusion: A single preoperative intravenous infusion of magnesium sulphate (50 mg/kg) delivers superior and more sustained postoperative analgesia than dexamethasone (8 mg) following cesarean section under spinal anaesthesia, with fewer rescue analgesic requirements. Dexamethasone retains an edge in antiemetic and antishivering prophylaxis. These complementary profiles open the door to rational, individualized adjuvant selection in obstetric anaesthetic practice.

Keywords: magnesium sulphate, dexamethasone, pre-emptive analgesia, spinal anaesthesia, cesarean section

CTRI No: CTRI/2019/12/022545

BACKGROUND

Every surgical incision is, at its core, a calculated insult — the controlled disruption of tissue in service of healing. For the patient, that disruption does not end when the skin is closed. The hours that follow the scalpel are shaped largely by the quality of analgesia, and nowhere is this more consequential than in obstetric surgery, where a mother must recover swiftly enough to hold, feed, and bond with her newborn.

Spinal anaesthesia — the elegant delivery of local anaesthetic into the subarachnoid space — has long been the gold standard for cesarean section. Its virtues are well-established: rapid onset, dense sensory and motor blockade, haemodynamic predictability, and a substantially lower risk of systemic toxicity compared with general anaesthesia. Yet it carries an inherent limitation. Single-dose intrathecal bupivacaine is, by design, transient. As the block retreats, patients frequently

encounter breakthrough pain, delayed ambulation, and a reflexive escalation in opioid requirements that introduces its own burden of side effects.

Pre-emptive analgesia — the administration of analgesics before the onset of nociceptive stimuli — has gained considerable traction as a strategy to blunt the central sensitization that underlies much of postoperative pain. Among the pharmacological candidates, two agents have attracted particular interest for intravenous administration: magnesium sulphate, a physiological NMDA receptor antagonist that modulates pain transmission at the spinal cord level, and dexamethasone, a potent glucocorticoid with well-documented analgesic, antiemetic, and anti-inflammatory properties. Both have demonstrated efficacy as individual adjuvants, yet comparative data in the cesarean section setting remain limited. This trial was designed to fill that gap.

METHODS

The study was designed as a prospective, randomized, double-blinded comparative trial conducted after approval from the institutional scientific and ethics committees. Sample size was estimated using nMaster 2.0 software based on the prior work of Rezaei et al., assuming a superiority margin of 2.7 hours, 80% power, and a 5% alpha error. This yielded a requirement of 31 patients per group (total n = 62). All eligibility criteria were rigorously predefined and adhered to throughout the recruitment period.

Pre-anaesthetic evaluation was conducted for each patient, and written informed consent was obtained after a thorough explanation of the study procedure. Patients were kept nil per oral for 8 hours prior to surgery. On arrival to the operating theatre, standard ASA perioperative monitoring was established — encompassing heart rate, non-invasive blood pressure, electrocardiography, pulse oximetry, respiratory rate, urine output, and core temperature.

Baseline hemodynamic parameters were recorded at time zero and at 10-minute intervals throughout the procedure. An 18-G intravenous cannula was secured and balanced salt solution was infused as preload. Group A received magnesium sulphate 50 $mg \cdot kg^{-1}$ diluted in 100 mL of 0.9% saline, administered as a 15-minute infusion. Group B received dexamethasone 8 mg in an identical-appearing 100 mL infusion over the same duration. Study drugs were prepared in the preoperative area by personnel blinded to outcome assessment, ensuring concealment.

Patients were then positioned in the lateral decubitus position, the lumbar spine was exposed, and subarachnoid block was performed at the L3–L4 interspace using a 25-G Quincke's needle with 10 mg of 0.5% hyperbaric bupivacaine. The moment of intrathecal injection completion was designated as time zero, with all subsequent durations referenced from this point. Patients were immediately repositioned supine and supplemental oxygen was delivered via face mask at 6 L/min.

Intraoperatively, sensory block was evaluated using the Modified Hollman score, and motor block was assessed with the Modified Bromage scale, both performed at 2-minute intervals during the first 15 minutes. The onset of sensory block was defined as time to bilateral T6 analgesia; duration of sensory block as regression to T10. Motor block onset was defined as time to Bromage 1 score, with recovery indicated by a return to Bromage 0. The duration of spinal anaesthesia was defined as the interval from injection to the first patient-reported incisional pain.

Postoperatively, pain was assessed using the Visual Analogue Scale (VAS) at standard intervals over 24 hours. Rescue analgesia — either Tramadol or Paracetamol injection — was administered on patient request when VAS exceeded 3. Oxytocin was given per AMTSL protocol after cord clamping. Standard postoperative monitoring continued for 24 hours, encompassing heart rate, blood pressure, deep tendon reflexes, and urine output. Breastfeeding was initiated at the earliest opportunity. Neonatal APGAR scores at 1 and 5 minutes were recorded by a blinded paediatrician.

Adverse effects systematically monitored included hypotension, shivering, excessive blood loss, nausea, and vomiting. Nausea and vomiting were graded on validated scales: nausea from Grade 0 (absent) through Grade 3 (no oral intake); vomiting from Grade 0 (absent) through Grade 4 (>10 episodes in 24 hours). Patients requiring conversion to general anaesthesia due to inadequate block were excluded post hoc.

RESULTS

All 62 enrolled participants completed the study per protocol. Baseline demographic characteristics — age, weight, height, and BMI — were well-matched between groups, as were ASA classification scores (Table 1), confirming robust randomization.

Table 1: Demographic Profile

VARIABLES		Group A (n=31)	Group B (n=31)	P value	Test
Age (yrs)	Mean ± SD	25.48 ± 3.96	25.71 ± 4.80	0.84	t-test

VARIABLES		Group A (n=31)	Group B (n=31)	P value	Test
Weight (kg)	Mean ± SD	63.81 ± 7.56	62.32 ± 7.88	0.452	t-test
Height (cm)	Mean ± SD	156.81 ± 2.89	156.39 ± 4.75	0.676	t-test

Hemodynamic Parameters

Intraoperative heart rates were broadly comparable between groups, with transient but statistically significant divergence at 15, 20, and 25 minutes — attributed to reflex tachycardia secondary to the vasodilatory effect of magnesium. Neither group exhibited clinically meaningful excursions beyond the normal range. Systolic blood pressure followed a similar trajectory; a statistically significant difference emerged at 15 minutes ($p = 0.026$), while diastolic pressure diverged significantly at 15, 20, and 25 minutes ($p<0.0001$), reflecting magnesium's known hypotensive mechanism. In Group A, six patients required a dose of ephedrine (6 mg IV) to manage transient hypotension. Oxygen saturation and respiratory rate remained comparable and statistically indistinguishable throughout.

The mean operative duration was virtually identical — 46.94 ± 13.82 minutes in Group A and 46.61 ± 13.81 minutes in Group B — confirming that surgical complexity was balanced across the trial.

Sensory Block Duration

Magnesium sulphate extended sensory anaesthesia by nearly 30 minutes compared to dexamethasone (Table 2). This difference was highly statistically significant ($p<0.0001$) and clinically meaningful, providing patients in Group A with a substantially longer window of pain-free recovery before breakthrough discomfort emerged.

Table 2: Duration of Sensory Block

Duration of sensory block (minutes)	Group A (n=31)	Group B (n=31)	P value	Test
Mean ± SD	172.9 ± 6.58	143.16 ± 8.62	<0.0001	t-test

Motor Block Duration

Motor recovery was also significantly delayed in the magnesium group (Table 3), with a difference of approximately 28 minutes ($p<0.0001$). While prolonged motor block is generally acceptable in

the postoperative setting, the clinical team monitored all patients to ensure recovery to baseline Bromage 0 prior to mobilization.

Table 3: Duration of Motor Block

Duration of motor block (minutes)	Group A (n=31)	Group B (n=31)	P value	Test
Mean ± SD	162.65 ± 6.13	134.16 ± 8.13	<0.0001	t-test

Postoperative Pain — VAS Scores

Table 4 presents the hour-by-hour pain narrative of the two groups. During the first two postoperative hours, when the residual spinal block rendered both groups comparably comfortable, VAS scores were indistinguishable. From the 4-hour mark onward, however, the divergence grew progressively — and significantly — in favour of magnesium sulphate. At 24 hours, Group A patients reported dramatically lower pain scores (1.26 ± 0.58 vs. 2.35 ± 0.75; $p<0.0001$), underscoring the durability of magnesium's analgesic effect well beyond the lifespan of the block itself.

Table 4: Postoperative VAS Scores

VAS Score (Mean ± SD)	Group A (n=31)	Group B (n=31)	P value	Test
Post-operative 0 hour	0.42 ± 0.67	0.29 ± 0.46	0.382	t-test
Post-operative 1 hour	1.68 ± 0.91	1.65 ± 1.23	0.906	t-test
Post-operative 2 hours	1.77 ± 1.02	2.1 ± 1.01	0.216	t-test
Post-operative 4 hours	1.19 ± 0.91	1.97 ± 1.35	0.01*	t-test
Post-operative 6 hours	2.19 ± 0.83	2.61 ± 1.09	0.093	t-test
Post-operative 8 hours	1.87 ± 1.06	2.52 ± 0.96	0.014*	t-test
Post-operative 12 hours	2.39 ± 0.76	3.1 ± 1.14	0.005*	t-test
Post-operative 18 hours	2.19 ± 0.83	3.06 ± 1.00	0.0004*	t-test
Post-operative 24 hours	1.26 ± 0.58	2.35 ± 0.75	<0.0001*	t-test

** Statistically significant ($p<0.05$)*

Time to First Rescue Analgesia

Patients who received magnesium sulphate waited substantially longer before requesting their first analgesic dose (Table 5). The 47-minute advantage (270.67 ± 67.97 min vs. 223.33 ± 60.22 min)

was highly significant (p<0.0001) and translated directly into improved patient comfort during the vulnerable early postoperative period. Crucially, no patient in either group required a second rescue analgesic dose, indicating that when relief was needed, a single dose sufficed — likely a reflection of the continued background analgesic effect of the study drugs.

Table 5: Time to First Rescue Analgesia

	Group A (n=31) Mean ± SD	Group B (n=31) Mean ± SD	P value
Time to 1st Rescue Analgesia (min)	270.67 ± 67.97	223.33 ± 60.22	<0.0001

Total Rescue Analgesic Consumption

The mean number of rescue analgesic doses required within 24 hours was significantly lower in Group A (2.87 ± 0.56) than in Group B (4.0 ± 0.73; p<0.0001). This reduction in rescue analgesic demand is one of the most clinically tangible markers of effective pre-emptive analgesia and corroborates the VAS and time-to-first-dose findings.

Neonatal Outcome

No adverse neonatal events were recorded in either group. APGAR scores at 1 and 5 minutes were comparable across groups and statistically indistinguishable, and no neonate required NICU admission. This is consistent with the reassuring safety profiles documented in prior studies of magnesium sulphate and dexamethasone at these doses and routes of administration.

Adverse Effects — Shivering

Here, the tables turned in dexamethasone's favour. More than half of Group A patients (54.84%) experienced postoperative shivering, compared with only 16.13% in Group B — a difference that was strongly significant (p=0.001; Table 6). This is consistent with magnesium's known mechanism of peripheral vasodilation, which may impair thermoregulation. Dexamethasone's anti-inflammatory and membrane-stabilizing properties appear to confer meaningful protection against this troublesome complication.

Table 6: Postoperative Shivering

Shivering	Group A (n=31)	Group B (n=31)	P value	Test
No	14 (45.16%)	26 (83.87%)	0.001	Chi-square

Shivering	Group A (n=31)	Group B (n=31)	P value	Test
Yes	17 (54.84%)	5 (16.13%)		
Total	31 (100%)	31 (100%)		

Adverse Effects — Nausea and Vomiting

Nausea and vomiting rates did not reach statistical significance between groups (p=0.157), yet there was a clear directional trend toward better gastrointestinal tolerance in the dexamethasone arm (Table 7). Notably, Grade 2 nausea occurred in 12.9% of Group A patients but was entirely absent in Group B — a finding with meaningful implications for patient recovery and early oral intake.

Table 7: Postoperative Nausea and Vomiting

Nausea/Vomiting	Group A (n=31)	Group B (n=31)	P value	Test
Grade 0	15 (48.39%)	18 (58.06%)	0.157	Fisher Exact
Grade 1	12 (38.71%)	13 (41.94%)		
Grade 2	4 (12.90%)	0 (0%)		
Total	31 (100%)	31 (100%)		

DISCUSSION

This trial asked a clinically important question: when only one intravenous adjuvant can be chosen to augment postoperative analgesia for cesarean section under spinal anaesthesia, which should it be — magnesium sulphate or dexamethasone? The answer, at least on the primary analgesic dimension, was unambiguous.

Demographic Profile

The two groups were well-matched at baseline. All 62 participants carried ASA II status, as expected in a healthy obstetric population. There were no statistically significant differences in age, weight, or height (all p>0.05), confirming that observed between-group differences in outcomes are attributable to the interventions rather than pre-existing variation.

Motor Block

Magnesium sulphate prolonged motor blockade by approximately 28 minutes relative to dexamethasone — a finding that aligns with its established mechanism as an NMDA receptor antagonist and calcium channel blocker that suppresses motor neuron excitability at the spinal level. This is consistent with Raju et al., who demonstrated significantly prolonged motor block (155.94 ± 5.18 min vs. 122.45 ± 6.19 min in controls) using the same dose of intravenous magnesium in patients undergoing arthroscopic knee surgery under spinal anaesthesia with hyperbaric bupivacaine and fentanyl. Zhong et al. similarly reported that magnesium sulphate 50 mg/kg significantly extended both sensory and motor blockade in preeclamptic patients receiving spinal bupivacaine (motor block 194.6 ± 35.4 min vs. 175.7 ± 27.6 min in controls; $p<0.05$).

For dexamethasone, Parthasarathy et al. reported a statistically significant prolongation of motor block (220.17 ± 24.93 min vs. 203.83 ± 24.09 min in controls) following a single intravenous dose in patients under spinal anaesthesia, while Shalu et al. found a non-significant difference in an elective cesarean section population — a heterogeneity that likely reflects differences in patient population, dose timing, and concurrent medications.

Sensory Block

The sensory block findings were equally compelling, with Group A demonstrating a 30-minute advantage over Group B (172.9 ± 6.58 min vs. 143.16 ± 8.62 min; $p<0.0001$). Magnesium's capacity to blunt NMDA-mediated central sensitization appears to be the operative mechanism — inhibiting the wind-up phenomenon that amplifies pain perception at the dorsal horn. These results echo Zhong et al.'s observations in preeclamptic patients, where sensory block duration was significantly prolonged (261.3 ± 64.7 min vs. 226.5 ± 56.4 min in controls), and Shalu et al.'s findings that intravenous dexamethasone similarly extended sensory block in cesarean section patients (162.50 min vs. 106.17 min in controls; $p<0.05$), albeit to a lesser degree than magnesium.

Postoperative Pain

The VAS trajectory tells the clearest story. In the immediate postoperative window (0–2 hours), both groups benefited from residual spinal analgesia and scores were indistinguishable. From 4 hours onwards, the magnesium group consistently reported lower pain scores — with statistically significant differences at 4, 8, 12, 18, and 24 hours. This temporal pattern is mechanistically coherent: pre-emptive NMDA blockade attenuates the central sensitization that typically drives escalating pain intensity as the spinal block wears off.

Shah et al., in a retrospective analysis of parturients receiving postoperative magnesium infusions, likewise found reduced pain scores and total analgesic requirements over 24 hours following cesarean delivery. Shalu et al. confirmed that dexamethasone meaningfully extends the duration of postoperative analgesia — yet our head-to-head data indicate that this effect falls short of the protection conferred by magnesium.

Time to First Rescue Analgesia and Total Analgesic Consumption

The 47-minute extension in time to first analgesic request — and the significant reduction in total rescue dose burden — are perhaps the most clinically actionable findings of this trial. In the postoperative ward, each avoided analgesic dose translates into less opioid burden, fewer side effects for the mother, and greater capacity for early ambulation and breastfeeding.

These findings are supported by the meta-analytic work of McKeown et al., who concluded that preoperative intravenous magnesium reduces total post-cesarean rescue analgesic consumption, and Heesen et al., who demonstrated a significantly prolonged time to first analgesic request with intravenous dexamethasone (mean difference 86.82 min vs. control) — an effect that, while clinically meaningful in isolation, was surpassed by magnesium in our direct comparison.

Hemodynamic Variables

Magnesium sulphate's vasodilatory properties are well-recognized, and our data reflected this. Transient hypotension was observed at 15 minutes intraoperatively in the systolic blood pressure, and at 15, 20, and 25 minutes in the diastolic — manageable with intravenous fluid supplementation and a single dose of ephedrine (6 mg IV) when required. This pattern mirrors that reported by Maulik et al. in severe preeclamptics receiving magnesium for spinal augmentation, where intraoperative hypotension was more frequent than in controls. Dexamethasone, by contrast, exerted no clinically significant hemodynamic perturbation — consistent with Shalu et al.'s finding that dexamethasone not only prolongs postoperative analgesia but stabilizes vital signs, an attribute with particular relevance in obstetric patients who are already physiologically vulnerable.

Neonatal Outcome

Both study drugs were neonatally safe at the doses employed. APGAR scores were comparable, no baby required intensive care, and all neonates were fit for early initiation of breastfeeding. This is consistent with Zhong et al.'s reassuring data for magnesium (APGAR 8.6 ± 1.3 vs. 8.9 ± 1.5 in

controls at 1 min; p=0.414) and Patnaik et al.'s confirmation of neonatal safety with preoperative dexamethasone in the cesarean section context. Notably, antenatal magnesium sulphate carries the added benefit of fetal neuroprotection in preterm births — a further argument for its use in the obstetric theatre, even where this was not the primary indication.

Adverse Effects

The adverse effect profile revealed a meaningful divergence that carries practical implications for patient selection. Postoperative shivering affected more than half of Group A patients (54.84%) compared to just 16.13% in Group B (p=0.001) — a consequence of magnesium's vasodilatory effect impairing thermoregulation. Destaw et al. have demonstrated that dexamethasone is as effective as pethidine in preventing post-spinal shivering, and our data reinforce this antiShivering property as a genuine clinical advantage of the glucocorticoid. Similarly, while nausea and vomiting rates did not differ significantly overall, the severity distribution favoured dexamethasone — no patient in Group B experienced Grade 2 nausea, compared to 12.9% in Group A. Dexamethasone's antiemetic mechanism, mediated through prostaglandin inhibition and serotonin pathway modulation, appears clinically operative even at this dose.

CONCLUSION

In obstetric patients undergoing elective cesarean section under spinal anaesthesia, a single preoperative intravenous infusion of magnesium sulphate (50 mg/kg) delivers superior and more durable postoperative analgesia than dexamethasone (8 mg) — reflected in significantly prolonged sensory and motor block, lower VAS pain scores through 24 hours, a longer time to first rescue analgesia, and a substantially reduced total analgesic burden. Dexamethasone, however, offers meaningful complementary advantages: a more favourable shivering profile and better gastrointestinal tolerance. Together, these findings support rational, individualized adjuvant selection — and raise the possibility that a judicious combination approach may one day offer the best of both worlds. Future adequately powered trials comparing combination regimens against either drug alone would be a valuable next step.

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