Research Article

Prophylactic Intravenous Dexamethasone Versus Low-Dose Ketamine For Prevention Of Post-Spinal Shivering In Elective Cesarean Delivery: A Randomized Double-Blind Controlled Trial

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Abstract

Background: Shivering is a frequent complication following spinal anesthesia and is related to elevated oxygen consumption, extensive metabolic requirements, maternal agitation, and disruption of perioperative monitors during cesarean section under spinal anesthesia. Several pharmacological agents have been used for its prevention, including dexamethasone and low-dose ketamine.
Objective: The current study compared the effectiveness and safety of using low-dose ketamine and intravenous dexamethasone immediately before spinal anesthetic for preventing post-spinal anesthetic shivering in women who underwent perioperative spinal anesthetic for elective cesarean section.
Methods: A randomized, double-blind, controlled clinical trial was conducted on 160 pregnant women (ASA I-II) scheduled for elective cesarean section under spinal anesthesia at Arash Hospital, Tehran University of Medical Sciences. Participants were randomly allocated into two equal groups (n=80 each). Low-dose ketamine (0.2 mg/kg) rectally was also administered to the ketamine group before spinal anesthesia, while dexamethasone (4 mg intravenous) was administered to the dexamethasone group. Demographic parameters, hemodynamic parameters, incidence, severity, and shivering, the effects of shivering on the mother, and neonatal outcomes were documented.
Results: The baseline demographic and obstetric parameters were similar across groups ($p>0.05$). Neonatal outcomes showed no significant differences. Maternal hemodynamics remained stable; however, immediately after spinal anesthesia, heart rate and blood pressure were significantly higher in the ketamine group ($p<0.05$). The incidence of shivering was lower in the dexamethasone group. A statistically significant difference was observed at 10 minutes after spinal anesthesia, with a greater proportion of patients remaining shivering-free in the dexamethasone group compared with the ketamine group (92.5% vs. 77.5%, $p=0.04$). No differences were observed for maternal adverse effects or neonatal outcomes.
Conclusion: Both prophylactic intravenous dexamethasone and low-dose ketamine were safe and effective for preventing post-spinal anesthesia shivering. Dexamethasone demonstrated superior control of shivering with a statistically significant advantage at 10 minutes after spinal anesthesia, while maintaining an excellent maternal and neonatal safety profile.

Keywords: Dexamethasone, Ketamine, Spinal anesthesia, Cesarean section, Post-spinal shivering, Maternal hemodynamics, Neonatal outcomes.

Introduction

Shivering is an involuntary somatic motor response triggered by exposure to cold environments or fever. It is defined by involuntary, oscillatory muscular contraction, which elevates the production of metabolic heat up to 600% higher than the bas al metabolic rate (1). Various conditions can cause shivering, including fever, movement disorders, fear, excitement, stress, hypoglycemia, anxiety, postanesthetic states, and spinal anesthesia. Post-anesthetic shivering is a relatively frequent event, ranging from 50% to 65%, especially for those women undergoing cesarean section (2). It is caused by the peripheral vasodilation and redistribution of heat away from the core following sympathetic blockade. Shivering is regarded as a minor perioperative complication, but can elevate oxygen consumption, carbon dioxide output, metabolic rates, and cardiac output, and can be highly uncomfortable to the patient and disrupt intraoperative monitoring (3). Spinal anesthesia remains the preferred anesthetic technique for elective cesarean section because of its rapid onset, simplicity, and reduced maternal and neonatal complications compared with general anesthesia (4). However, neuraxial blockade alters normal thermoregulatory control by decreasing vasoconstriction and shivering thresholds, predisposing parturients to perioperative hypothermia and subsequent shivering (5). Several pharmacological and non-pharmacological strategies have been investigated to prevent post-spinal shivering. Pharmacological prophylaxis is widely accepted because it is simple, effective, and inexpensive (6). Various agents, including meperidine, tramadol, clonidine, dexmedetomidine, ketamine, and dexamethasone, have demonstrated variable efficacy in reducing the incidence and severity of perioperative shivering (7). Ketamine, a noncompetitive N-methyl-D-aspartate (NMDA) receptor antagonist, possesses anti-shivering properties through modulation of central thermoregulation and

stimulation of the sympathetic nervous system (8). Several studies have demonstrated that prophylactic low-dose ketamine effectively reduces the incidence of shivering after spinal anesthesia, including in patients undergoing cesarean delivery (9,10). Dexamethasone is a long-acting corticosteroid with potent anti-inflammatory and immunomodulatory properties (11). Although its precise anti-shivering mechanism is not fully understood, it is believed to suppress inflammatory mediators and reduce the release of pyrogenic cytokines that regulate body temperature (12,13). In addition, dexamethasone provides beneficial perioperative effects, including the prevention of nausea and vomiting, reduction of postoperative pain, and enhancement of recovery following cesarean section (14). Previous clinical studies have evaluated ketamine and dexamethasone either individually or in comparison with other pharmacological agents for the prevention of shivering and other perioperative complications during cesarean delivery under spinal anesthesia (15,16). Ameta et al. demonstrated that prophylactic ketamine reduced the incidence of post-spinal shivering, although dexmedetomidine showed superior efficacy (17). Similarly, Emami reported that low-dose ketamine tended to provide better protection against perioperative complications than dexamethasone during cesarean section under spinal anesthesia, although differences in shivering incidence were not statistically significant (18). Despite these findings, direct comparisons of prophylactic low-dose ketamine with dexamethasone for the prevention of post-spinal shivering in parturients remain limited, and the existing data are inconclusive (19). Therefore, this study was designed to compare the efficacy and safety of prophylactic intravenous dexamethasone and low-dose ketamine in preventing shivering following spinal anesthesia for elective cesarean section. Maternal hemodynamic parameters and neonatal immediate outcomes of both interventions were secondary outcomes.

Materials & Methods

Study Design

This prospective, randomized, double-blind controlled trial was conducted to compare the efficacy of prophylactic intravenous dexamethasone and low-dose ketamine in preventing post-spinal shivering among women undergoing elective cesarean delivery under spinal anesthesia. The study was conducted at Arash Hospital, Tehran University of Medical Sciences (TUMS), Tehran, Iran, during the period 2025–2026. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrollment.

Study Population

A total of 160 full-term pregnant women scheduled for elective cesarean delivery under spinal anesthesia were enrolled in the study. Eligible participants were aged between 18 and 40 years and classified as American Society of Anesthesiologists (ASA) physical status I or II. Women with contraindications to spinal anesthesia, known hypersensitivity to either study drug, significant systemic disease, pre-existing neurological disorders, or refusal to participate were excluded from the study.

Randomization and Blinding

Participants were randomly assigned to one of two equal groups (n = 80 each) using a computer-generated randomization sequence. Allocation concealment was ensured using sequentially numbered, sealed opaque envelopes. The study followed a double-blind design in which both the participants and the investigators responsible for perioperative monitoring, data collection, and outcome assessment were unaware of treatment allocation.

Intervention

Participants in the dexamethasone group received 4 mg intravenous dexamethasone approximately 15 minutes before spinal anesthesia. Participants in the ketamine group received low-dose intravenous ketamine (0.2 mg/kg), administered slowly over 1–2 minutes before spinal anesthesia.

Anesthetic Technique

Spinal anesthesia was performed according to the institutional standard protocol under strict aseptic conditions. Standard perioperative monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and body temperature monitoring. Baseline vital signs were recorded before administration of the study medications and monitored throughout the intraoperative and early postoperative periods.

Outcome Measures

The primary outcome was the incidence of post-spinal shivering. Shivering severity was assessed using the Bedside Shivering Assessment Scale (BSAS). The secondary outcomes were maternal hemodynamics, adverse drug effects (hypotension, bradycardia, nausea, vomiting, sedation, and hallucinations), and neonatal effects (Apgar score at 1 and 5 minutes).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 25.0 (IBM Corp., Armonk, NY, USA). Data distribution was assessed before selecting the appropriate statistical tests. Continuous variables were expressed as mean ± standard deviation (SD) and compared using Student's t-test or the Mann–Whitney U test, as appropriate. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Results

A total of 160 women undergoing elective cesarean delivery under spinal anesthesia completed the study and were randomly allocated to either the ketamine group (n = 80) or the dexamethasone group (n = 80). No participants were excluded after randomization.

Baseline Demographic and Obstetric Characteristics

The demographic and baseline maternal characteristics were comparable between the two groups. No statistically significant differences were observed in age, body mass index, parity, maternal comorbidities, neonatal sex, or Apgar scores at 1 and 5 minutes (Table 1). Neonatal vital signs, including heart rate, oxygen saturation, respiratory rate, and body temperature, were also comparable between the groups, with no statistically significant differences.

Table 1: Demographic characteristics and baseline maternal and neonatal data of the study groups.

Variable		Ketamine (n=80)	Dexamethasone (n=80)	p-value
Age (years)		27.81 ± 7.44	29.03 ± 6.90	0.36
BMI (kg/m²)		31.50 ± 5.37	32.05 ± 5.64	0.53
Apgar (1 min)		8.24 ± 0.73	8.24 ± 0.73	1.00
Apgar (5 min)		9.59 ± 0.50	9.60 ± 0.49	0.75
Parity	**First**	16 (20.0%)	23 (28.8%)	0.23
	Second	20 (25.0%)	15 (18.8%)	
	Third	17 (21.3%)	23 (28.8%)	
	Fourth	27 (33.8%)	19 (23.8%)	
Condition	**Diabetes**	13 (16.3%)	8 (10.0%)	0.61
	Hypertension	6 (7.5%)	7 (8.8%)	
	Hyperthyroidism	10 (12.5%)	8 (10.0%)	
	None	51 (63.8%)	57 (71.3%)	
Gender	**Female**	47 (58.8%)	43 (53.8%)	0.52
	Male	33 (41.3%)	37 (46.3%)	

Neonatal Vital Signs

Neonatal vital signs following delivery showed no statistically significant differences between the ketamine and dexamethasone groups. Mean neonatal heart rate was 140.54 ± 12.30 bpm in the ketamine group compared with 140.24 ± 11.92 bpm in the dexamethasone group (p = 0.51). Similarly, oxygen saturation (97.76 ± 1.75% vs. 97.28 ± 1.71%, p = 0.55), respiratory rate, and body temperature were comparable between the groups. These findings indicate that both prophylactic agents are safe for the neonate and do not adversely affect immediate neonatal well-being.

Maternal Vital Signs

Table 2 presents a summary of maternal vital signs at baseline and at critical time points after intervention. Respiratory rate remained constant at 12 breaths per minute in both groups throughout all measurement time points. The results revealed the following:

Before Spinal Anesthesia (Baseline): Heart rate was significantly higher in the ketamine group compared with the dexamethasone group (96.39 ± 16.31 vs. 87.28 ± 14.47 bpm, p < 0.001), while all other vital signs were comparable between the groups.

Immediately After Spinal Anesthesia: Statistically significant differences were observed, with heart rate (99.98 ± 11.15 vs. 96.51 ± 7.73 bpm, p = 0.024), systolic blood pressure (105.91 ± 8.96 vs. 103.53 ± 3.95 mmHg, p = 0.031), diastolic blood pressure (50.25 ± 14.87 vs. 42.01 ± 1.57 mmHg, p < 0.001), and mean arterial pressure (87.14 ± 9.26 vs. 81.98 ± 9.65 mmHg, p = 0.001)

being significantly higher in the ketamine group. This is attributed to the sympathomimetic effect of ketamine, which may be beneficial in counteracting the hypotensive effects of spinal anesthesia.
At 10 and 15 Minutes After Intervention: Vital signs stabilized in both groups, and no statistically significant differences were observed between them at either time point ($p > 0.05$ for all).

Table 2: Maternal Vital Signs at Critical Time Points

Parameter	Group	Baseline	After Spinal	10 min	15 min
HR (bpm)	Ketamine	96.39 ± 16.31*	99.98 ± 11.15*	87.00 ± 8.70	80.71 ± 7.17
	Dexamethasone	87.28 ± 14.47	96.51 ± 7.73	84.89 ± 6.35	79.29 ± 5.89
SBP (mmHg)	Ketamine	121.30 ± 14.11	105.91 ± 8.96*	115.35 ± 5.33	120.34 ± 6.52
	Dexamethasone	124.70 ± 10.45	103.53 ± 3.95	115.21 ± 3.02	120.15 ± 3.41
DBP (mmHg)	Ketamine	79.00 ± 11.71	50.25 ± 14.87*	65.58 ± 7.39	70.11 ± 4.81
	Dexamethasone	80.65 ± 8.29	42.01 ± 1.57	65.49 ± 3.09	70.20 ± 3.10
MAP (mmHg)	Ketamine	93.38 ± 11.14	87.14 ± 9.26*	98.77 ± 5.46	103.55 ± 5.05
	Dexamethasone	93.96 ± 13.81	81.98 ± 9.65	97.44 ± 11.25	102.19 ± 11.83
SpO_2 (%)	Ketamine	99.30 ± 0.83	99.49 ± 0.97	99.48 ± 0.64	99.49 ± 0.57
	Dexamethasone	99.28 ± 0.73	99.50 ± 0.96	99.44 ± 0.59	99.46 ± 0.57

Data are presented as mean ± standard deviation. Statistically significant difference between groups ($p < 0.05$).

Maternal Clinical Outcomes

Shivering

The incidence of shivering, any grade, is shown in Table 3 for all time points. The highest incidence of shivering was observed at 5 and 10 minutes in both groups. A statistically significant difference was observed at 10 minutes, where 22.5% of patients in the ketamine group experienced shivering compared with only 7.5% in the dexamethasone group ($p = 0.04$). This finding is consistent with the shivering-free rates shown in Figure 1, confirming the superior efficacy of dexamethasone in controlling post-spinal shivering.

Figure 1: Shivering-Free Rates Across Time Points

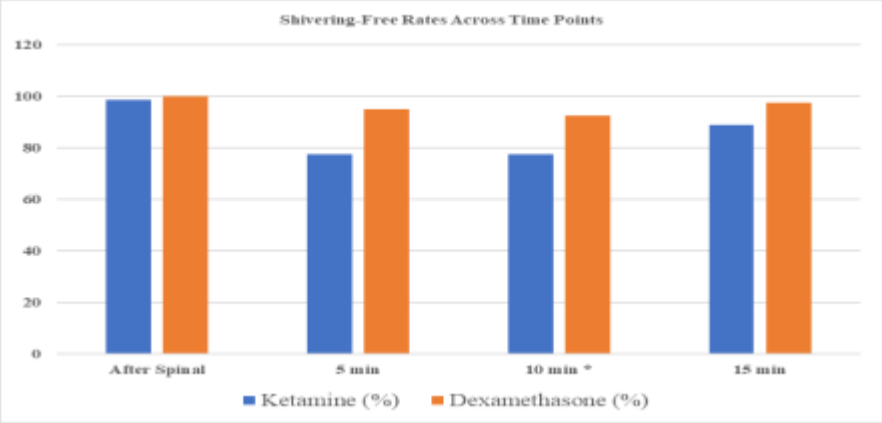

Table 3: Incidence of Shivering (Any Grade) Across Time Points

Time after spinal anesthesia	Ketamine n (%)	Dexamethasone n (%)	p-value
Immediately after spinal anesthesia	1 (1.3)	0 (0.0)	0.08
5 min	18 (22.5)	4 (5.0)	0.08
10 min	18 (22.5)	6 (7.5)	0.04
15 min	9 (11.3)	2 (2.5)	0.11

Table 3 presents the incidence of shivering (any grade) across all time points. The highest incidence of shivering was observed at 5 and 10 minutes in both groups. A statistically significant difference was observed at 10 minutes, where 22.5% of patients in the ketamine group experienced shivering compared with only 7.5% in the dexamethasone group ($p = 0.04$). This finding is consistent with the shivering-free rates shown in Figure 1, confirming the superior efficacy of dexamethasone in controlling post-spinal shivering.

Adverse Effects

The adverse effects reported at all time points are summarised in Table 4. Adverse effects were extremely rare in both groups. In one patient in the ketamine group (1.3%) nausea was reported at 5 minutes and at 10 minutes; in the same patient vomiting was reported at 10 minutes. No cases of nausea or vomiting were reported in the dexamethasone group. During the entire study period, there were no occurrences of hallucinations or psychotomimetic effects in both groups. The results of this study showed that both agents, given at the recommended prophylactic dose, possess an excellent safety profile in the mother.

Table 4: Adverse Effects Across All Time Points

Time Point	Outcome	Ketamine Group (n=80)	Dexamethasone Group (n=80)	p-value
After Spinal Anesthesia	Nausea	0 (0%)	0 (0%)	1.00
	Vomiting	0 (0%)	0 (0%)	1.00
	Hallucination	0 (0%)	0 (0%)	1.00
5 Minutes	Nausea	1 (1.3%)	0 (0%)	0.31
	Vomiting	0 (0%)	0 (0%)	1.00
	Hallucination	0 (0%)	0 (0%)	1.00
10 Minutes	Nausea	1 (1.3%)	0 (0%)	0.31
	Vomiting	1 (1.3%)	0 (0%)	0.31
	Hallucination	0 (0%)	0 (0%)	1.00
15 Minutes	Nausea	0 (0%)	0 (0%)	1.00
	Vomiting	0 (0%)	0 (0%)	1.00
	Hallucination	0 (0%)	0 (0%)	1.00

Summary of Findings

1. Baseline Homogeneity: Both groups were well-balanced in all demographic and clinical characteristics before intervention.
2. Neonatal Safety: Neither agent adversely affected neonatal vital signs or Apgar scores.
3. Hemodynamic Profile: Ketamine demonstrated a significant pressor and chronotropic effect immediately after spinal anesthesia ($p < 0.05$ for HR, SBP, DBP, and MAP), while dexamethasone was more hemodynamically stable. Vital signs stabilized in both groups at later time points. There was no change in respiratory rate during the whole observation period.
4. Shivering Prevention: Both agents were effective in preventing shivering; however, dexamethasone showed superior control with a statistically significant advantage at 10 minutes after spinal anesthesia ($p = 0.04$).
5. Safety Profile: Both agents demonstrated an excellent safety profile, with minimal nausea/vomiting in the ketamine group and a complete absence of hallucinations.

Discussion

The present randomized double blind controlled trial aimed to compare the efficacy of prophylactic intravenous dexamethasone versus low dose ketamine in prevention of post-spinal anesthesia shivering in 160 women scheduled for elective cesarean section under spinal anesthesia (3). The findings demonstrate that both interventions are safe and effective, with dexamethasone showing a modest clinical advantage in controlling shivering, particularly at 10 minutes after spinal anesthesia (20).

The baseline demographic and obstetric characteristics were comparable between the two groups, confirming successful randomization and ensuring valid comparison. This is consistent with Lema et al. (2017), who reported similar baseline homogeneity in their study comparing anti-shivering agents during cesarean delivery (16). Regarding neonatal safety, no significant differences were observed in Apgar scores or vital signs between the groups, supporting the findings of AbdElmawgood et al. (2012) that low-dose ketamine does not adversely affect neonatal adaptation (21).

Maternal hemodynamic parameters remained stable throughout the perioperative period in both groups. However, immediately after spinal anesthesia, heart rate and blood pressure were significantly higher in the ketamine group compared with the dexamethasone group. This can be attributed to the sympathomimetic activity of ketamine, which raises circulating catecholamine levels and counteracts the hypotensive effects of spinal anesthesia. Similar findings were reported by AbdElmawgood et al. (2012), who demonstrated improved hemodynamic stability with prophylactic ketamine. Notably, all vital signs stabilized within 5 to 15 minutes in both groups, suggesting that these hemodynamic effects are transient and well-tolerated (21). Research has shown that the stability of vital signs, especially blood pressure control, can play an effective role in improving people's quality of life (22,23).

The principal finding of this study was superior control of shivering with dexamethasone at 10 minutes after spinal anesthesia, with 92.5% of patients remaining shivering-free compared with 77.5% in the ketamine group (p = 0.04). Although this difference was statistically significant only at this time point, the overall trend favored dexamethasone across all assessment intervals. The anti-shivering effect of dexamethasone is likely mediated through its anti-inflammatory properties, suppression of pyrogenic cytokines, and reduction of thermoregulatory disturbances, as suggested by Kalawa et al. (2025) (24). Conversely, the anti-shivering effect of ketamine is largely attributed to NMDA receptor antagonistic effects and modulation of central thermoregulatory pathways, as suggested by Lema et al., (2017) and Dal et al., (2005). The lack of statistical significance at other time points may be due to the low overall incidence of shivering, which reduced the power to detect differences (16,25).

Both agents demonstrated excellent tolerability. No hallucinations were observed in either group, and only one patient (1.3%) in the ketamine group experienced nausea and vomiting, while no adverse effects were reported in the dexamethasone group. These favorable safety characteristics are similar to other studies and justify the general use of both agents during obstetric anesthesia.

The study has several strengths, including its randomized double-blind design, adequate sample size, and standardized anesthetic technique. However, limitations include the single-center design, inclusion of only elective cases with healthy obstetric status (ASA I-II), and the absence of long-term follow-up. These factors may reduce the applicability of these findings to emergency settings or cases of high-risk pregnancies.

Clinically, both agents can be considered safe prophylactic options. Although dexamethasone is used because it provides better shivering control, ketamine also has the advantage of being hemodynamically stable. The distinction between the two should be individualized based on patient's characteristics and contraindications. Future multicenter studies with larger samples and diverse populations are recommended to confirm these findings and explore optimal dosing regimens (26).

In conclusion, both dexamethasone and low-dose ketamine are safe and effective for preventing post-spinal shivering. Dexamethasone has been shown to have superior control with a statistically significant advantage at 10 minutes after spinal anesthesia, making it a preferable choice, and low dose ketamine is a useful alternative when corticosteroids are contraindicated.

Conclusion

The present study demonstrated that both prophylactic intravenous dexamethasone (4 mg) and low-dose ketamine (0.2 mg/kg) were safe and effective for reducing the incidence of post-spinal shivering in women undergoing elective cesarean delivery under spinal anesthesia. Favorable maternal and neonatal safety outcomes were seen for both drugs, with no clinically significant adverse effects.

Dexamethasone had a tendency to its greater ability to control post-spinal shivering compared with low-dose ketamine, but the difference at 10 minutes after the dawn of spinal anesthesia was statistically significant, with no significant differences in other outcome parameters, including hemodynamic stability or neonatal outcomes. However, ketamine was linked to a higher heart rate and blood pressure immediately following spinal anesthesia, which has sympathomimetic effects.

Based on these findings, prophylactic intravenous dexamethasone may be considered a promising option for the prevention of post-spinal shivering during elective cesarean delivery. However, low dose ketamine is still a viable option as an alternative, especially for patients who cannot receive the corticosteroid injection. Additional multicenter trials using even larger and more diverse patient cohorts are suggested to confirm these results as to optimize prophylactic measures for post-spinal shivering.

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