Volume 3, Issue 4, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

COMPARISON OF LOW DOSE OF KETAMINE VERSUS TRAMADOL IN PREVENTION OF POST SPINAL ANESTHESIA SHIVERING IN ELECTIVE CESAREAN SECTION

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DOI: https://doi.org/10.5281/zenodo.17990734

Keywords
Post-spinal anesthesia shivering, Ketamine, Tramadol, Elective cesarean section

Article History
Received: 11 April 2025
Accepted: 21 June 2025
Published: 28 June 2025

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Abstract

Background: *Post-spinal anesthesia shivering (PAS) is a common and distressing complication during cesarean section, leading to increased oxygen consumption, sympathetic stimulation, and patient discomfort. Various pharmacological agents, including ketamine and tramadol, have been used for prophylaxis, but comparative data remain limited.*

Objective: *To compare the effectiveness of low-dose ketamine versus tramadol in preventing post-spinal anesthesia shivering in elective cesarean section.*

Methods: *This quasi-experimental study was conducted at Northwest General Hospital, Peshawar, from September 2024 to March 2025. Ninety-two term pregnant women (ASA I–II) scheduled for elective cesarean section under spinal anesthesia were enrolled and allocated into two groups: Group A received ketamine 0.2 mg/kg IV, and Group B received tramadol 0.5 mg/kg IV immediately after spinal anesthesia. Shivering was assessed using the Crossley and Mahajan scale intraoperatively and for 45 minutes postoperatively. Rescue pethidine (25 mg IV) was administered for persistent shivering. Adverse effects and hemodynamic parameters were recorded.*

Results: *Shivering occurred in 23.9% of patients in the ketamine group versus 39.1% in the tramadol group ($p = 0.04$). Moderate-to-severe shivering was more frequent in the tramadol group. Rescue pethidine was required in 6.5% of ketamine patients compared to 15.2% in the tramadol group. Nausea and vomiting were higher in the tramadol group, while mild sedation was more common with ketamine. No serious adverse events were observed.*

Conclusion: *Low-dose ketamine is more effective and better tolerated than tramadol in preventing post-spinal anesthesia shivering during elective cesarean section.*

INTRODUCTION

Post-anesthetic shivering (PAS) is a frequent and distressing complication following both general and regional anesthesia, particularly spinal anesthesia. It is characterized by involuntary

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ISSN: (e) 3007-1607 (p) 3007-1593

muscular activity and is commonly observed in the perioperative and postoperative periods. The reported incidence of PAS varies widely, ranging from 5–65% after general anesthesia and 40–60% following regional anesthesia, depending on patient characteristics, type of surgery, and anesthetic technique [1,2].

Shivering is not merely an unpleasant sensation but is associated with significant physiological consequences. It increases oxygen consumption and carbon dioxide production, elevates metabolic rate, interferes with electrocardiographic and pulse oximetry monitoring, and may lead to lactic acidosis. Furthermore, shivering induces sympathetic stimulation with increased catecholamine release, which may precipitate cardiovascular stress, elevate intracranial and intraocular pressures, and worsen outcomes in vulnerable patients [3].

Cesarean section performed under spinal anesthesia is particularly associated with a high incidence of shivering. Pregnant women are prone to heat loss due to sympathetic blockade, peripheral vasodilation, exposure to cold operating room environments, and infusion of unwarmed intravenous fluids. These factors collectively impair thermoregulation and increase the risk of shivering during and after surgery, making its prevention an important aspect of obstetric anesthesia care [4].

Various pharmacological agents have been studied for the prevention and treatment of PAS. These include opioids such as tramadol and meperidine, α_2-agonists like clonidine and dexmedetomidine, serotonin receptor antagonists, anticholinergics, and N-methyl-D-aspartate (NMDA) receptor antagonists such as ketamine. Despite the availability of multiple options, no single drug has been universally accepted as the ideal agent due to differences in efficacy, side-effect profiles, and patient tolerability [5].

Tramadol is a centrally acting analgesic with weak μ-opioid receptor agonist activity and inhibitory effects on the reuptake of serotonin and norepinephrine. Its antishivering effect is attributed to modulation of central monoaminergic pathways involved in thermoregulation. Several studies have demonstrated its effectiveness in reducing the incidence and severity of post-spinal anesthesia shivering, with minimal respiratory depression, making it a commonly used agent in obstetric practice [6].

Ketamine, a non-competitive NMDA receptor antagonist, exerts antishivering effects through modulation of central thermoregulatory pathways, including inhibition of excitatory neurotransmission and interaction with serotonergic and noradrenergic systems in the locus coeruleus. Low doses of ketamine have been shown to effectively prevent shivering without causing significant psychomimetic effects or hemodynamic instability, making it a promising alternative in spinal anesthesia [7].

Previous studies comparing ketamine and tramadol for prevention of post-spinal anesthesia shivering in cesarean section have reported variable results, with no clear consensus regarding superiority of either drug. Differences in dosing, study populations, and outcome measures contribute to this inconsistency. Moreover, local data comparing these agents in obstetric patients remain limited, highlighting the need for further randomized controlled trials to guide evidence-based practice [8].

Objective:

To compare the effectiveness of low-dose ketamine versus tramadol in the prevention of post-spinal anesthesia shivering in patients undergoing elective cesarean section.

Materials and methods

This quasi-experimental comparative study was conducted in the Department of Anesthesiology at Northwest General Hospital, Peshawar, from **29 September 2024 to 28 March 2025**, after obtaining approval from the hospital's Ethical and Research Committee. The study included term pregnant women aged 18–35 years, classified as American Society of Anesthesiologists (ASA) physical status I or II, who underwent elective cesarean section under spinal anesthesia. Written informed consent was obtained from all participants after explaining the

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ISSN: (e) 3007-1607 (p) 3007-1593

objectives, procedures, and potential benefits of the study.

Patients were excluded if they had hypersensitivity to ketamine or tramadol; a history of cardiovascular disease, psychosis, hypertension, substance abuse, or opioid use; body temperature below 36°C or above 38°C; fetal distress, cord prolapse, or significant intraoperative or postoperative bleeding; requirement for blood transfusion; failed spinal anesthesia; or conversion to general anesthesia. These exclusion criteria were strictly applied to reduce confounding and ensure uniformity of the study population.

A total of 92 patients were enrolled using consecutive non-probability sampling. Participants were allocated into two equal groups of 46 patients each according to the study protocol. Group A received low-dose ketamine (0.2 mg/kg), while Group B received tramadol (0.5 mg/kg). The study drugs were prepared in identical 5-mL syringes by an anesthesiologist not involved in data collection and were administered intravenously as a bolus immediately after confirmation of adequate spinal anesthesia.

On arrival in the operating room, an 18-gauge intravenous cannula was inserted, and patients were preloaded with Ringer's lactate at a dose of 10 mL/kg over 15 minutes. Standard monitoring, including electrocardiography, non-invasive blood pressure, heart rate, and oxygen saturation, was applied to all patients. Spinal anesthesia was performed in the sitting position at the L3–L4 or L4–L5 interspace using a 27-gauge pencil-point needle, and 12.5 mg of hyperbaric bupivacaine was administered intrathecally.

The adequacy of the spinal block was assessed using the pinprick test for sensory level and the Bromage scale for motor block. A sensory block level between T4 and T6 and a Bromage score of 3 were considered acceptable for proceeding with surgery. After spinal anesthesia, patients were positioned supine and received oxygen at 4 L/min via face mask. No premedication or active warming measures were used during the perioperative period.

Shivering was assessed using the Crossley and Mahajan grading scale. Observations were recorded every five minutes during surgery and continued for up to 45 minutes in the postoperative recovery area. A shivering score of ≥2 at any point during the observation period was considered significant and was recorded as post-spinal anesthesia shivering.

In cases of persistent or severe shivering, intravenous pethidine 25 mg was administered after clamping of the umbilical cord. Bradycardia, defined as a heart rate below 50 beats per minute, was treated with atropine 0.5 mg intravenously. Hypotension, defined as a systolic blood pressure below 100 mmHg or a decrease of more than 20% from baseline, was managed with intravenous ephedrine 5 mg. Nausea and vomiting were treated with intravenous metoclopramide 10 mg. Hemodynamic parameters and any adverse drug reactions were documented throughout the perioperative period.

All data were recorded on a predesigned proforma and analyzed using SPSS version 23. Continuous variables, including age, body mass index, and duration of surgery, were expressed as mean ± standard deviation or median with interquartile range after assessing data normality using the Shapiro–Wilk test. Categorical variables, including the presence of post-spinal anesthesia shivering, were presented as frequencies and percentages. Comparisons between the two groups were performed using the chi-square test or Fisher's exact test, as appropriate. Stratification was conducted for age, body mass index, and duration of surgery to assess effect modification. A p-value of ≤0.05 was considered statistically significant.

Results

A total of 92 patients undergoing elective cesarean section under spinal anesthesia were included in the final analysis, with 46 patients allocated to each group. All enrolled patients completed the study without protocol deviations. Group A received low-dose ketamine (0.2

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mg/kg), while Group B received tramadol (0.5 mg/kg).

The baseline demographic and perioperative characteristics of the study participants are presented in **Table 1**. The mean age of patients in the ketamine group was 27.8 ± 4.1 years, compared to 28.2 ± 4.3 years in the tramadol group. Body mass index, duration of surgery, and ASA physical status were comparable between the two groups, and no statistically significant differences were observed, indicating homogeneity of the study population.

Table 1: Baseline Demographic and Perioperative Characteristics of Study Participants

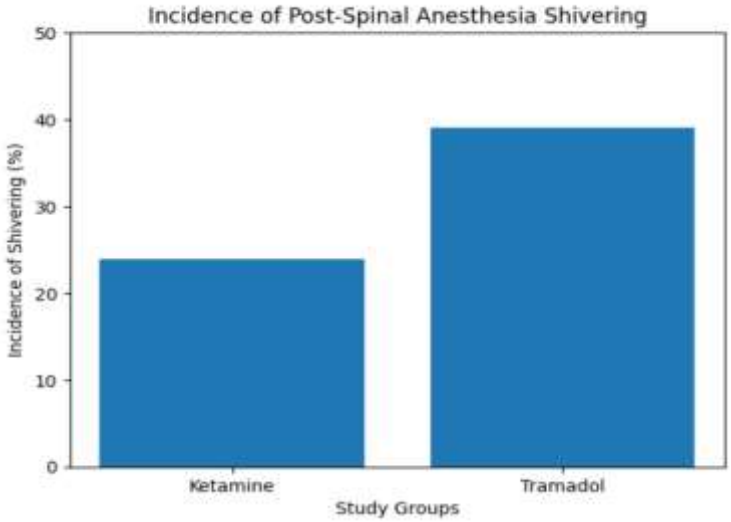
Variable	Ketamine Group (n = 46)	Tramadol Group (n = 46)	p-value
Age (years)	27.8 ± 4.1	28.2 ± 4.3	0.64
Body mass index (kg/m²)	26.1 ± 2.8	26.4 ± 2.6	0.58
Duration of surgery (minutes)	49.6 ± 6.7	50.3 ± 7.1	0.61
ASA physical status (I / II)	30 / 16	28 / 18	0.65

Post-spinal anesthesia shivering occurred less frequently in patients who received low-dose ketamine compared to those who received tramadol. Shivering, defined as a Crossley and Mahajan score of ≥2, was observed in 11 patients (23.9%) in the ketamine group and in 18 patients (39.1%) in the tramadol group. This difference was statistically significant ($p = 0.04$), demonstrating a lower incidence of post-spinal anesthesia shivering in the ketamine group **(Table 2)**.

Table 2: Comparison of Incidence of Post-Spinal Anesthesia Shivering Between Study Groups

Post-spinal anesthesia shivering	Ketamine Group (n = 46)	Tramadol Group (n = 46)	p-value
Present	11 (23.9%)	18 (39.1%)	0.04
Absent	35 (76.1%)	28 (60.9%)	

Figure 1: Graph showing comparison of shivering incidence between ketamine and tramadol groups



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ISSN: (e) 3007-1607 (p) 3007-1593

The severity of shivering based on the Crossley and Mahajan grading scale is shown in **Table 3**. The majority of patients in the ketamine group either did not develop shivering or experienced mild shivering. In contrast, moderate to severe shivering (grades 3 and 4) was more frequently observed in the tramadol group. The overall distribution of shivering severity differed significantly between the two groups (p = 0.03).

Table 3: Severity of Post-Spinal Anesthesia Shivering According to Crossley and Mahajan Scale

Shivering grade	Ketamine Group (n = 46)	Tramadol Group (n = 46)
Grade 0	35 (76.1%)	28 (60.9%)
Grade 1	6 (13.0%)	7 (15.2%)
Grade 2	4 (8.7%)	7 (15.2%)
Grade 3	1 (2.2%)	3 (6.5%)
Grade 4	0 (0%)	1 (2.2%)

Adverse effects and the requirement for rescue medication are summarized in **Table 4**. Nausea and vomiting were more frequently observed in the tramadol group, whereas mild sedation was more common in the ketamine group but did not require intervention. Rescue pethidine for persistent shivering was required in 3 patients (6.5%) in the ketamine group and in 7 patients (15.2%) in the tramadol group, with a statistically significant difference between the two groups (p = 0.04). No serious adverse events were recorded during the study period.

Table 4: Adverse Effects and Rescue Medication Requirement

Variable	Ketamine Group (n = 46)	Tramadol Group (n = 46)	p-value
Nausea / vomiting	4 (8.7%)	10 (21.7%)	0.04
Bradycardia	2 (4.3%)	1 (2.2%)	0.55
Hypotension	3 (6.5%)	4 (8.7%)	0.69
Rescue pethidine required	3 (6.5%)	7 (15.2%)	0.04

Discussion

Post-spinal anesthesia shivering remains a frequent and clinically relevant complication in obstetric anesthesia, particularly during cesarean section. In the present study, low-dose ketamine (0.2 mg/kg) was found to be more effective than tramadol (0.5 mg/kg) in reducing the incidence of post-spinal anesthesia shivering. Patients receiving ketamine demonstrated a significantly lower frequency and severity of shivering compared to those receiving tramadol, highlighting the potential advantage of ketamine as a prophylactic agent in this setting [9,10].

The reduced incidence of shivering observed with ketamine may be attributed to its multifactorial mechanism of action. Ketamine acts as an N-methyl-D-aspartate (NMDA) receptor antagonist and modulates thermoregulation at both central and spinal levels. It also influences serotonergic and noradrenergic pathways in the locus coeruleus, which play an important role in temperature regulation. These mechanisms likely contribute to its superior efficacy in preventing shivering after spinal anesthesia [11,12].

Tramadol has been widely studied for the prevention and treatment of post-anesthetic shivering due to its opioid and monoaminergic properties. Although tramadol was effective in reducing shivering compared to no prophylaxis, its efficacy was lower than that of ketamine in the

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ISSN: (e) 3007-1607 (p) 3007-1593

present study. Similar findings have been reported by previous investigators, who demonstrated higher rates of residual shivering with tramadol, particularly during obstetric procedures where thermoregulatory impairment is more pronounced [13,14].

The findings of this study are consistent with earlier comparative trials that reported a lower incidence of shivering in patients receiving ketamine compared to tramadol during cesarean section under spinal anesthesia. Jouryabi et al. and Lema et al. also observed better prophylactic efficacy with ketamine, although the absolute incidence rates varied due to differences in study design, drug dosing, ambient temperature, and patient characteristics [15,16]. These variations highlight the importance of local data in guiding clinical practice.

In addition to reducing the incidence of shivering, ketamine was associated with lower shivering severity scores. Most patients in the ketamine group experienced either no shivering or only mild shivering, whereas moderate to severe shivering was more frequently observed in the tramadol group. This reduction in severity is clinically relevant, as higher grades of shivering are associated with increased oxygen consumption, patient discomfort, and interference with intraoperative monitoring [17,18].

Regarding safety, both ketamine and tramadol were well tolerated in the present study. Nausea and vomiting were more common in the tramadol group, which is consistent with the known emetogenic potential of tramadol. Mild sedation was more frequently observed in the ketamine group but did not require intervention and was not associated with adverse maternal or neonatal outcomes. These findings support the safety of low-dose ketamine in obstetric patients when used judiciously [19,20].

Despite its strengths, this study has certain limitations. The quasi-experimental design and use of non-probability sampling may limit the generalizability of the findings. Blinding of patients was not ensured, which may have introduced observer bias. Additionally, neonatal outcomes such as Apgar scores and maternal satisfaction were not assessed, and long-term follow-up was not conducted. Future multicenter studies with larger sample sizes and randomized designs are recommended to validate these findings [21].

Conclusion

In conclusion, this study demonstrates that low-dose ketamine (0.2 mg/kg) is more effective than tramadol (0.5 mg/kg) in preventing post-spinal anesthesia shivering in patients undergoing elective cesarean section. Ketamine not only reduced the incidence but also decreased the severity of shivering, providing better patient comfort and potentially minimizing associated physiological stress. Both drugs were generally well tolerated, though tramadol was associated with a higher incidence of nausea and vomiting, whereas ketamine caused mild sedation without significant adverse effects. These findings suggest that low-dose ketamine can be considered a safe and superior prophylactic agent for shivering in obstetric patients receiving spinal anesthesia, supporting its use in clinical practice.

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