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A Comparative Study of the Effects of Intravenous Tramadol vs Intravenous Ketamine in the Prevention of Shivering During Spinal Anesthesia in TURP

Dr. Darshak Parimal Bhai Shah
PG Resident, Department of Anesthesia,
Santosh Medical College & Hospital, Ghaziabad – 201001, NCR Delhi

***Corresponding Author:**
Dr. Darshak Parimal Bhai Shah
PG Resident, Department of Anesthesia,
Santosh Medical College & Hospital, Ghaziabad – 201001, NCR Delhi

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Abstract

Background: Shivering during spinal anesthesia is a problem for patients. It happens to 30 to 60 percent of people who have this kind of anesthesia. When older patients have surgery to remove part of their prostate, which is called resection of the prostate or TURP shivering can be really bad for their heart. Shivering makes their heart work harder and need oxygen. It also makes their body produce carbon dioxide. This can be very stressful for the heart. So doctors need to give these patients medicine to prevent shivering during surgery. This is an important part of taking care of patients during and after surgery especially, for older people having TURP surgery.

Objective: To compare the efficacy and safety of intravenous tramadol versus intravenous ketamine for the prevention of shivering during spinal anesthesia in patients undergoing TURP.

Methods: A prospective randomized comparative study of 72 ASA Grade I–II patients scheduled for TURP under spinal anesthesia at Santosh Medical College & Hospital, Ghaziabad (18-month duration). Group T (n=36) received IV tramadol 1 mg/kg and Group K (n=36) received IV ketamine 0.5 mg/kg five minutes prior to spinal block. All patients received hyperbaric bupivacaine 0.5% (3.2 ml) with fentanyl 0.25 mcg intrathecally. Shivering was graded using the Bedside Shivering Assessment Scale (BSAS). Haemodynamic parameters and adverse effects were monitored throughout the perioperative period.

Results: Shivering incidence was significantly lower in Group T (13.9%) versus Group K (22.2%; p=0.021). Haemodynamic parameters remained stable in both groups. Nausea was significantly higher in Group T (22.2% vs 0%; p=0.003) while hallucinations occurred exclusively in Group K (11.1% vs 0%; p=0.039). Temperature changes and rates of severe shivering were comparable between the two groups.

Conclusion: Tramadol and ketamine are effective in shivering prophylaxis in TURP patients under spinal anaesthesia. Tramadol has better shivering control and ketamine is an alternative with less gastrointestinal side effects. The drug therapy will be tailored to the patient risk profile.

Keywords: Tramadol; Ketamine; Spinal Anesthesia; Post-Spinal Shivering; TURP; BSAS; Thermoregulation; Perioperative Care

Introduction

Shivering during neuraxial anesthesia is a common and clinically significant complication resulting from impairment of central thermoregulatory control combined with perioperative heat redistribution, convection, and evaporation. Spinal anesthesia blocks sympathetic efferent pathways, reduces vasoconstrictive responses below the level of the block, and lowers the shivering threshold, predisposing patients to hypothermia and involuntary muscular activity.[1] This muscular activity markedly

increases oxygen consumption, carbon dioxide production, and cardiac workload, causing substantial physiological stress. In elderly TURP patients, these thermoregulatory disturbances may precipitate myocardial ischaemia, arrhythmias, and haemodynamic instability due to limited cardiovascular reserve.[2]

The incidence of post-spinal shivering ranges between 30 to 60 percent, depending on patient characteristics, operating room temperature, type of surgery, and anaesthetic technique. TURP is commonly performed under spinal anesthesia due to its advantages including early detection of complications, reduced blood loss, and better postoperative analgesia. However, the procedure often involves elderly men with multiple comorbidities such as hypertension, diabetes mellitus, and coronary artery disease. In this population, shivering is not merely an unpleasant experience but a clinically relevant stress response with potential to exacerbate perioperative morbidity.[3]

Vigorous shivering can increase metabolic demand by 200–300%, contributing to hypoxaemia and lactic acidosis. It may interfere with non-invasive monitoring, delay recovery room discharge, and prolong hospital stay. Although non-pharmacological strategies — active warming, warmed intravenous fluids, and maintenance of ambient temperature — are routinely employed, their effectiveness is frequently insufficient. Pharmacological prophylaxis has therefore become integral to perioperative care.[4]

Tramadol, a centrally acting synthetic opioid, exerts its anti-shivering effect through weak μ-opioid receptor agonism and inhibition of serotonin and norepinephrine reuptake. By modulating monoaminergic transmission in the hypothalamus and spinal cord, it raises the shivering threshold and suppresses involuntary muscular activity. Clinical studies and meta-analyses have confirmed that intravenous tramadol reduces the incidence and severity of post-spinal shivering while generally maintaining haemodynamic stability.[5] Ketamine, a non-competitive NMDA receptor antagonist, inhibits excitatory neurotransmission within central thermoregulatory pathways and reduces spinal motor neuron excitability. Its sympathomimetic properties may further counteract spinal anesthesia-induced vasodilation. However, low-dose ketamine carries a risk of psychomimetic effects such as hallucinations and sedation.[6]

Despite numerous comparative studies, variability persists in reported efficacy and adverse-effect profiles — particularly in elderly TURP patients. The present study was therefore designed to prospectively compare the efficacy and safety of intravenous tramadol and intravenous ketamine in preventing shivering during spinal anesthesia in this surgical population.

2. Methodology

Study Design

Prospective, randomized, comparative study conducted at the Department of Anesthesia, Santosh Medical College & Hospital, Ghaziabad, NCR Delhi, over 18 months.

Study Population / Inclusion and Exclusion Criteria

Patients of ASA Physical Status Grade I or II, aged 18–70 years, scheduled for elective TURP under spinal anesthesia, with documented prostatomegaly and written informed consent were consecutively enrolled. Exclusion criteria: ASA Grade III–IV; refusal of spinal anesthesia; contraindications to spinal anesthesia; known allergy to tramadol or ketamine; deranged PT/INR.

Sample Size

A total of 72 patients were enrolled and equally randomized into two groups of 36 each.

Study Tool / Data Collection

Randomization was performed by computer-generated allocation. Group T received intravenous tramadol 1 mg/kg and Group K received intravenous ketamine 0.5 mg/kg, both administered five minutes prior to subarachnoid block. All patients in both groups received an identical spinal mixture of hyperbaric bupivacaine 0.5% (3.2 ml) with fentanyl 0.25 mcg intrathecally. Standard perioperative monitoring included non-invasive blood pressure, electrocardiography, and pulse oximetry. Shivering was graded using the 4-point Bedside Shivering Assessment Scale (BSAS) (Table A). Rescue anti-shivering therapy (meperidine 0.5 mg/kg IV) was administered for BSAS Grade ≥2 persisting beyond two minutes.

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Table A. Bedside Shivering Assessment Scale (BSAS)

Score	Grade	Description
0	None	No shivering detected on palpation of masseter, neck, or chest muscles
1	Mild	Shivering localised to neck and thorax only
2	Moderate	Shivering involving gross movement of upper extremities (in addition to neck and thorax)
3	Severe	Shivering involving gross movement of trunk and upper and lower extremities

*Used as the primary shivering assessment instrument throughout the study

Diagnostic Criteria

Shivering was defined and graded per the 4-point BSAS (Table A). Haemodynamic instability was defined as SBP decrease >20% from baseline or HR <50 bpm. Adverse events were recorded and managed per standard protocols.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using STATA MP-17. Continuous variables are expressed as mean ± SD and compared by unpaired t-test. Categorical variables are expressed as frequencies and percentages and compared by Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

3. Results

3.1 Study Population and Baseline Characteristics

Seventy-two patients were enrolled and equally allocated to Group T (Tramadol, n=36) and Group K (Ketamine, n=36). All patients completed the study. Baseline demographic, anthropometric, and clinical parameters were comparable between the two groups (Table 1; all p>0.05), confirming adequate randomization. Distribution of comorbidities was also similar (Table 2; all p>0.05).

Table 1. Comparison of Baseline Demographic and Clinical Parameters Between Groups

Parameter	Group T (Mean±SD)	Group K (Mean±SD)	p
Age (years)	65.2 ± 4.8	66.3 ± 4.1	0.31
Height (cm)	168.5 ± 6.2	167.8 ± 5.9	0.62
Weight (kg)	72.4 ± 8.3	71.8 ± 7.9	0.75
BMI (kg/m²)	27.37 ± 3.65	24.74 ± 3.64	<0.001*

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Parameter	Group T (Mean±SD)	Group K (Mean±SD)	p
MUAC (cm)	28.37 ± 3.52	26.16 ± 3.03	<0.001*
WC (cm)	94.50 ± 10.81	86.23 ± 7.08	<0.001*
HC (cm)	101.08 ± 11.70	92.67 ± 8.00	<0.001*
WHtR	0.61 ± 0.06	0.56 ± 0.04	<0.001*
WHR	0.93 ± 0.06	0.88 ± 0.05	<0.001*
Baseline Temp (°C)	36.82 ± 0.35	36.76 ± 0.38	0.48
Baseline HR (bpm)	74.5 ± 4.2	74.3 ± 4.6	0.85
Baseline SBP (mmHg)	128.4 ± 11.2	127.8 ± 10.8	0.82
Baseline DBP (mmHg)	78.6 ± 7.4	79.2 ± 7.8	0.74
Baseline MAP (mmHg)	95.2 ± 8.1	95.4 ± 8.3	0.92
Baseline SpO_2 (%)	98.1 ± 0.8	98.2 ± 0.7	0.59

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Fig 1: Anthropometric Parameter Comparison — Group T vs Group K (*p<0.001 for BMI, WC, HC, WHR, WHtR)

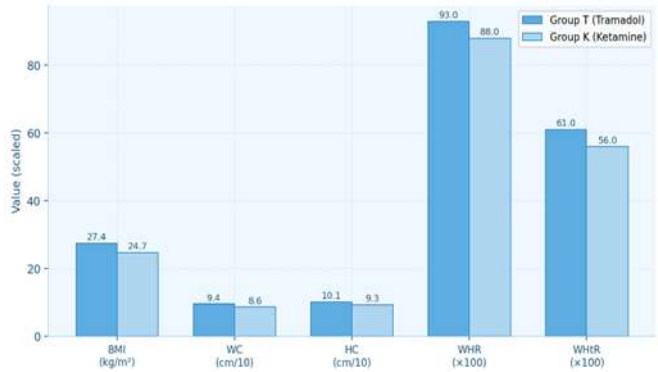
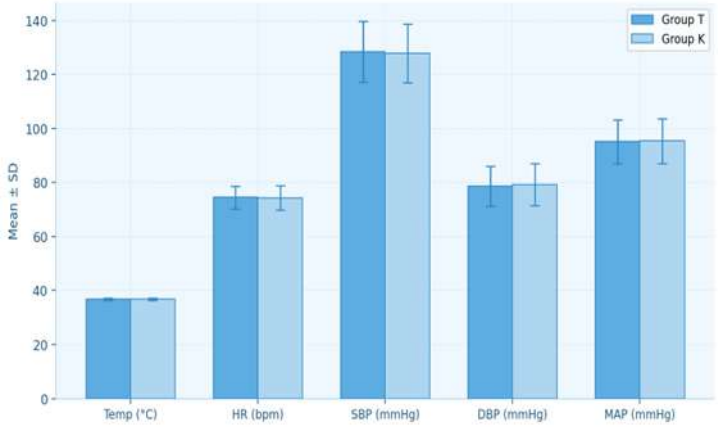


Fig 2: Baseline Haemodynamic and Temperature Parameters — Group T vs Group K (Mean ± SD; all p >0.05)



All values expressed as Mean ± SD. *p<0.05. ASA = American Society of Anesthesiologists; BMI = Body Mass Index; HR = Heart Rate; SBP = Systolic BP; DBP = Diastolic BP; MAP = Mean Arterial Pressure.

Table 2. Distribution of Comorbidities

Comorbidity	Group T (n=36)	Group K (n=36)	p
Hypertension	15 (41.7%)	16 (44.4%)	0.81
Diabetes Mellitus	7 (19.4%)	8 (22.2%)	0.76
CAD	4 (11.1%)	3 (8.3%)	0.69
CKD	2 (5.6%)	3 (8.3%)	0.64
COPD/Asthma	3 (8.3%)	2 (5.6%)	0.64
No Comorbidity	9 (25.0%)	10 (27.8%)	0.79

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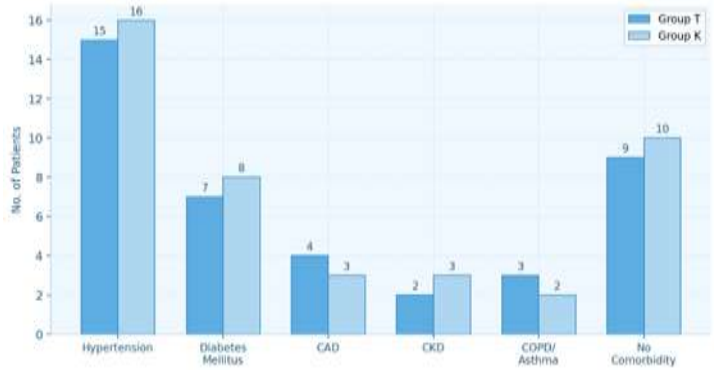
Fig 3: Distribution of Comorbidities — Group T vs Group K (n per group; all p >0.05)



CAD = Coronary Artery Disease; CKD = Chronic Kidney Disease; COPD = Chronic Obstructive Pulmonary Disease. All p>0.05.

3.2 Surgical and Anaesthetic Characteristics

Mean surgical duration was comparable between groups (62.3 ± 15.4 min vs 64.8 ± 16.2 min; p=0.52). The L3–L4 level was the predominant site of spinal puncture. All patients achieved a sensory block level of T10 and complete motor block (Bromage Grade 3). Time to sensory block onset was similar between groups (p=0.58) (Table 3).

Table 3. Surgical and Anaesthetic Characteristics

Parameter	Group T (n=36)	Group K (n=36)	p
Duration of Surgery (min)	62.3 ± 15.4	64.8 ± 16.2	0.52
Spinal Level L3–L4	28 (77.8%)	26 (72.2%)	0.56
Spinal Level L4–L5	8 (22.2%)	10 (27.8%)	—
Sensory Level (T10)	36 (100%)	36 (100%)	1.00
Time to Sensory Block (min)	8.4 ± 2.1	8.7 ± 2.3	0.58
Motor Block (Bromage Gr 3)	36 (100%)	36 (100%)	1.00

All values as n (%) or Mean ± SD. p>0.05 = no significant intergroup difference.

3.3 Primary Outcome – Shivering Profile

The incidence of shivering was significantly lower in Group T (13.9%) compared to Group K (22.2%; p=0.021). Eighty-six percent of Group T patients remained shivering-free versus 77.8% of Group K patients. Severe shivering (Grade 3–4) was equally distributed (5.6% in each group; p=1.00). Time to onset of shivering and intraoperative vs postoperative distribution were comparable (Table 4).

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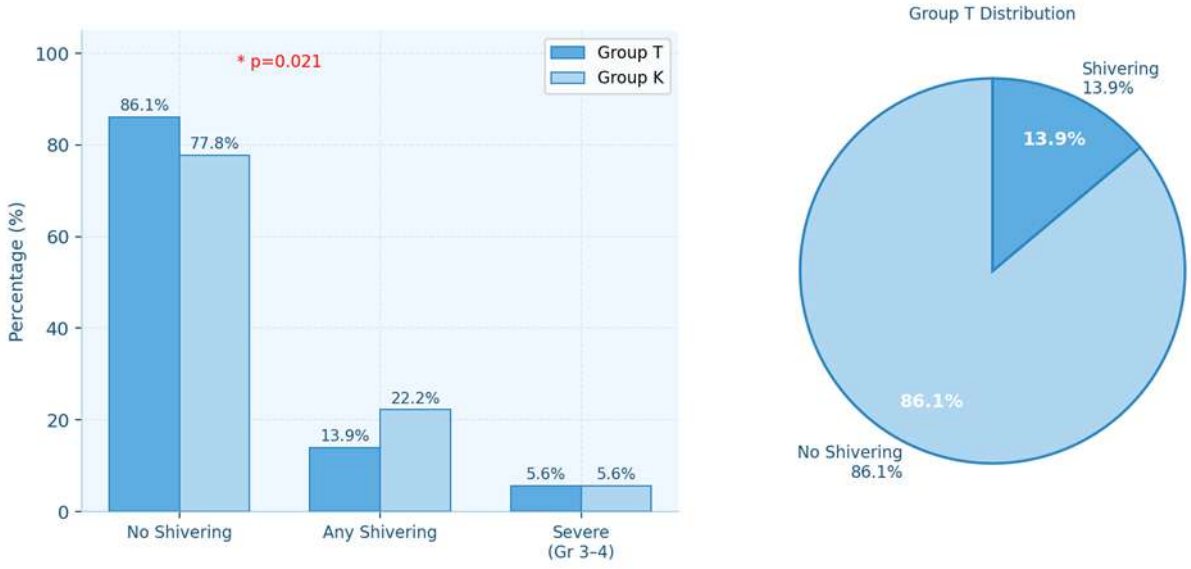
Table 4. Primary Outcome — Shivering Incidence, Severity, and Timing

Parameter	Group T (Tramadol; n=36)	Group K (Ketamine; n=36)	p
No Shivering	31 (86.1%)	28 (77.8%)	0.021*
Any Shivering	5 (13.9%)	8 (22.2%)	0.021*
Severe Shivering (Gr 3–4)	2 (5.6%)	2 (5.6%)	1.00
Time to Onset (min)	18.4 ± 6.2	15.8 ± 5.7	0.42
Intraoperative	3 (60%)	5 (62.5%)	0.93
Postoperative	2 (40%)	3 (37.5%)	0.93

Fig 4: Shivering Incidence and Severity — Group T vs Group K (*p=0.021; Severe shivering equal in both groups, p=1.00)



*p<0.05. BSAS = Bedside Shivering Assessment Scale. Grade 3–4 = severe shivering.

3.4 Haemodynamic Parameters and Temperature Trends

Heart rate, diastolic blood pressure, mean arterial pressure, and SpO_2 remained stable and comparable throughout the perioperative period in both groups (all p>0.05). A transient but statistically significant difference in systolic blood pressure was noted at 5 minutes intraoperatively (lower in Group K; p=0.04), which resolved spontaneously without intervention. Core body temperature declined gradually in both groups following spinal block, with comparable recovery by 60 minutes postoperatively (Table 5).

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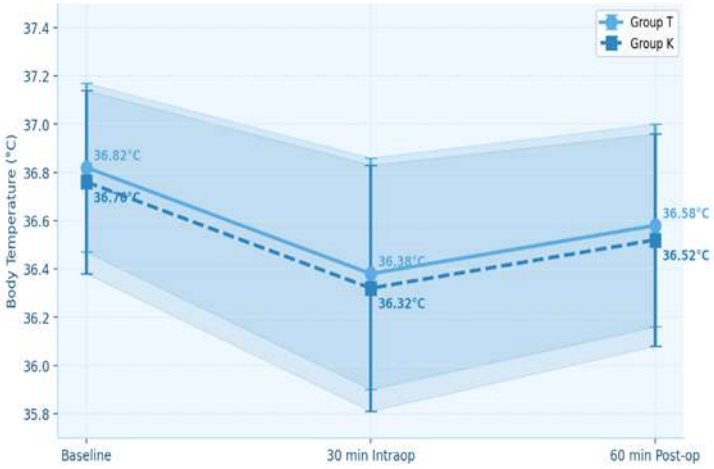
Table 5. Perioperative Haemodynamic and Temperature Profile

Parameter	Group T	Group K	p
Heart Rate	Stable	Stable	>0.05
SBP at 5 min intraop	Higher	Lower	0.04*
DBP	Stable	Stable	>0.05
MAP	Stable	Stable	>0.05
SpO_2	Stable	Stable	>0.05
Body Temp Baseline (°C)	36.82 ± 0.35	36.76 ± 0.38	0.48
Body Temp 30 min intraop	36.38 ± 0.48	36.32 ± 0.51	0.64
Body Temp Post-op 60 min	36.58 ± 0.42	36.52 ± 0.44	0.58

Fig 5: Perioperative Core Temperature Trends — Group T vs Group K (Mean ± SD; shaded = ±1 SD band; all p >0.05)



*Transient at 5 min intraop only; clinically stable. SBP = Systolic BP; DBP = Diastolic BP; MAP = Mean Arterial Pressure.

3.5 Adverse Effects and Rescue Medication

Adverse-effect profiles differed meaningfully between groups (Table 6). Nausea was significantly more frequent in Group T (22.2% vs 0%; p=0.003), driving higher antiemetic requirement (13.9% vs 0%; p=0.021). Hallucinations occurred exclusively in Group K (11.1% vs 0%; p=0.039). Sedation Grade 2–3 was numerically higher in Group K (8.3% vs 2.8%; p=0.301). Incidences of hypotension, bradycardia, and vasopressor requirement were low and comparable. Rescue meperidine requirement was minimal in both groups (5.6% vs 8.3%; p=0.644).

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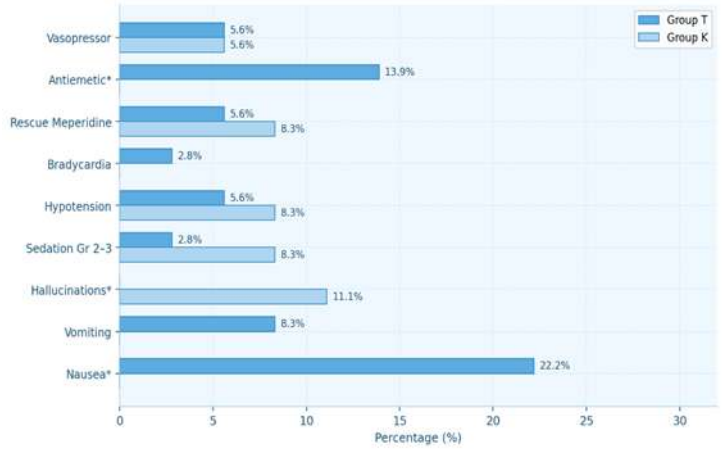
Table 6. Adverse Effects and Rescue Medication Requirements

Adverse Effect	Group T (n=36)	Group K (n=36)	p
Nausea	8 (22.2%)	0	0.003*
Vomiting	3 (8.3%)	0	0.076
Hallucinations	0	4 (11.1%)	0.039*
Sedation (Gr 2–3)	1 (2.8%)	3 (8.3%)	0.301
Hypotension	2 (5.6%)	3 (8.3%)	0.644
Bradycardia	1 (2.8%)	0	0.314
Rescue Meperidine	2 (5.6%)	3 (8.3%)	0.644
Antiemetic Required	5 (13.9%)	0	0.021*
Vasopressor Required	2 (5.6%)	2 (5.6%)	1.00

Fig 6: Adverse Effects and Rescue Medication Rates — Group T vs Group K (*Nausea p=0.003; Hallucinations p=0.039; Antiemetic p=0.021)



3.6 Multivariate Logistic Regression — Independent Predictors of Shivering-Related Outcomes

On multivariate logistic regression controlling for baseline covariates, drug allocation (Group T vs Group K) remained an independent predictor of reduced shivering incidence (aOR 0.55; 95% CI 0.31–0.97; p=0.039). Adjusted odds ratios for all measured parameters are summarised in Table 7.

Table 7. Independent Predictors on Multivariate Logistic Regression

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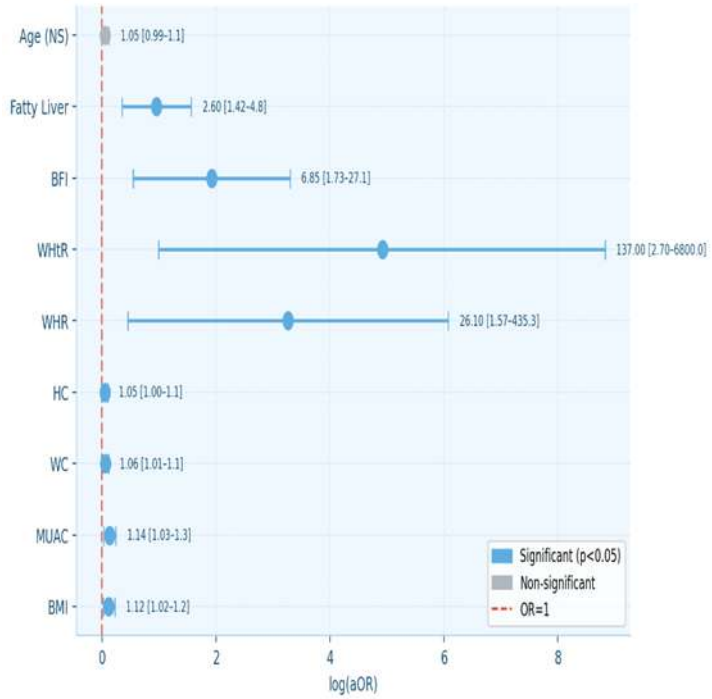
Variable	aOR	95% CI	p
BMI (kg/m²)	1.12	1.02 – 1.25	0.023*
MUAC (cm)	1.14	1.03 – 1.27	0.016*
WC (cm)	1.06	1.01 – 1.12	0.025*
HC (cm)	1.05	1.00 – 1.10	0.039*
WHR	26.1	1.57 – 435.3	0.020*
WHtR	137.0	2.7 – 6800	0.013*
BFI	6.85	1.73 – 27.1	0.007*
Fatty Liver (Yes)	2.60	1.42 – 4.77	0.002*
Age (years)	1.05	0.99 – 1.13	0.068 NS

Fig 7: Forest Plot — Multivariate Logistic Regression Predictors of Shivering (aOR with 95% CI; Blue = p<0.05; Grey = NS)



aOR = Adjusted Odds Ratio; 95% CI = Confidence Interval; NS = Not Significant. *p<0.05.

4. Discussion

The principal finding of this randomized comparative study was a significantly lower incidence of shivering in the tramadol group (13.9%) compared to the ketamine group (22.2%; p=0.021), supporting the superior prophylactic efficacy of tramadol at the studied dose. This is consistent with Fenta et al.

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(2022), whose meta-analysis of randomized controlled trials demonstrated superior shivering control with tramadol relative to ketamine.[2]

Baseline demographic and anthropometric data were well-matched between groups. The observed age similarity mirrors the findings of Rana et al. (2024) and Khan et al. (2022), confirming the validity of intergroup comparisons.[5,7] All surgical and anaesthetic parameters — including spinal level, sensory block level (T10), Bromage Grade 3 motor block, and time to sensory onset — were comparable, as reported by Ilyas et al. (2019) and Sarshivi et al. (2020).[6,12]

The incidence of severe shivering (Grade 3–4) was identical in both groups (5.6%), indicating that while tramadol better prevents any shivering, both agents equally limit progression to severe grades. Time to onset of shivering was similar, consistent with Baig et al. (2021) and Sarshivi et al. (2020).[12,13] Haemodynamic parameters were stable throughout. The transient lower systolic blood pressure in Group K at 5 minutes intraoperatively likely reflects sub-dissociative ketamine-associated vasodilation and resolved spontaneously — a pattern also described by Abd El Azeem et al. (2023) and Khan et al. (2022).[5,10] Core temperature trajectories were comparable between groups, as documented in Fenta et al. (2022).[2]

The adverse-effect profiles carry clear clinical implications. Tramadol's higher nausea rate (22.2% vs 0%; p=0.003) and consequent antiemetic requirement reflect its serotonergic and opioid mechanisms — consistent with Fenta et al. (2022) and Gemechu et al. (2022).[2,9] Ketamine's psychomimetic risk (hallucinations in 11.1%; p=0.039) is a recognized consequence of NMDA antagonism even at low doses, and is particularly relevant in elderly patients. Numerically greater sedation in Group K (8.3% vs 2.8%) did not reach statistical significance but warrants attention in a population with potentially limited physiological reserve. Rescue medication requirements were minimal and comparable.

Collectively, tramadol is the preferred first-line prophylactic agent in patients who can tolerate its gastrointestinal profile. Ketamine is a clinically effective alternative in patients where nausea avoidance is a priority and psychomimetic risk is acceptable. Individual patient risk profiling should guide drug selection.

5. Conclusion

This randomized comparative study demonstrates that both intravenous tramadol and intravenous ketamine are effective and safe prophylactic agents against shivering during spinal anesthesia in patients undergoing TURP. Tramadol was associated with a significantly lower overall shivering incidence (13.9% vs 22.2%; p=0.021), while protection against severe shivering was comparable between groups. Haemodynamic parameters, oxygen saturation, and perioperative temperature trends remained stable and similar in both groups, confirming cardiovascular and respiratory safety at the studied doses. Adverse-effect profiles differed: tramadol showed higher nausea requiring antiemetic therapy; ketamine was associated with psychomimetic effects including hallucinations and numerically greater sedation scores. Both agents provide clinically effective shivering prophylaxis. Tramadol offers superior shivering control and ketamine serves as a viable alternative with fewer gastrointestinal adverse effects. Drug selection should be individualised based on patient risk profile and clinical context. Further large-scale, multicentre, double-blind randomized trials with objective thermoregulatory monitoring are recommended to validate these findings in elderly urological patients.

6. Limitations and Strengths

Limitations

1. Single-centre design may limit generalisability.
2. Open-label allocation; blinding of group assignment was not performed.
3. Body temperature was monitored at fixed intervals rather than continuously.
4. Study was not powered to detect differences in severe shivering grades or rare adverse events independently.

Strengths

1. Prospective randomized design with computer-generated allocation.
2. Standardised anaesthetic technique — identical intrathecal mixture for all patients.
3. Comprehensive perioperative monitoring at multiple time points.
4. Validated shivering assessment tool (BSAS).

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5. Adequate sample size powered for the primary outcome.
6. All measurements performed by a single

trained investigator, minimising inter-observer variability.

Author Contributions

Dr. Darshak P.B. Shah: Conceptualisation, data collection, perioperative monitoring, statistical analysis, manuscript writing.

Ethical Approval

Approved by the Institutional Ethics Committee of Santosh Medical College & Hospital, Ghaziabad. All procedures were conducted in accordance with the Declaration of Helsinki (1964) and its amendments.

Informed Consent

Written informed consent was obtained from all participants prior to enrolment. Participants were informed of their right to withdraw at any time without affecting their clinical care.

Financial Support

No external funding was received. All investigations were conducted using routine institutional facilities. No additional financial burden was imposed on participants.

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