Effect of Tramadol versus Ketamine on Post-Spinal Anesthesia Shivering in Lower Limb Surgeries

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Abstract

Background: Spinal anesthesia is beneficial, but shivering might affect patient care. Shivering prophylaxis using Tramadol and Ketamine needs additional research, particularly for lower limb procedures.

Objectives: To compare Tramadol and Ketamine in reducing shivering after spinal anesthesia.

Patients and methods: A spinal anesthetic clinical study in Egypt comprised 100 adult lower limb surgery patients. They were evenly divided into ketamine (K) and tramadol (T) groups. Severe shivering was treated with pethidine 25 mg IV depending on sedation. Intraoperatively, vital signs and side effects were observed.

Results: Shivering was absent at 0-30 minutes in the Ketamine Group, but it increased subsequently (14% at 40 min, 20% at 50 min, 26% at 60 min). The Tramadol Group did not shiver at any time. The Ketamine Group had significant p-values for shivering over 40 minutes. RASS values were considerably lower in the Ketamine Group at 0, 10, and 20 min. RASS scores (30-60 min) were not significantly different. the Ketamine Group showed reduced SBP from 10 to 50 min and lower DBP at 10, 20, and 50 min, with no significant changes at 0, 30, 40, and 60 min. Continuously decreased heart rate in Ketamine Group from 10-60 min, with poorer oxygen saturation at 0 min but no significant difference at 10-60 min. Higher respiratory rate observed in Ketamine Group at 0 min and 10-30 min, but no significant changes at 40, 50, or 60 min.

Conclusion: Tramadol was the most effective preventive drug, minimizing shivering during surgery and improving sedative, cardiovascular, and respiratory parameters.

Keywords: Tramadol; Ketamine; Post-Spinal Anesthesia Shivering; Lower Limb Surgeries.

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Introduction

Spinal anesthesia, including lower limb surgeries, has become a well accepted and often utilized therapy in a wide range of surgical procedures. It is an attractive alternative for both patients and professionals because to its advantages, which include higher anesthetic quality and less systemic side effects than general anesthesia **(Kamel et al., 2022).**

Shivering is a common spinal anesthetic side effect that may result in patient discomfort, perioperative complications, and increased healthcare costs. Shivering may risk surgical safety and outcomes, as well as have an influence on patient satisfaction. As a consequence, preventing and controlling shivering during and after spinal anesthesia is a critical component of perioperative care **(Malekshoar et al., 2021).**

Tramadol and ketamine are two pharmacological drugs that have been studied for their ability to alleviate shivering. Both drugs are well-established in clinical practice, and they each work in a unique way. Tramadol, a centrally acting analgesic, has earned attention for its efficiency in preventing shivering, owing to its influence on the central nervous system **(Latif et al., 2020; Jabbari et al., 2021).**

Ketamine, a sympathomimetic dissociative anesthetic medication, on the other hand, has showed promise in lowering shivering during a number of surgical procedures. A little quantity of evidence, particularly in the context of lower limb treatments, directly compares Tramadol and Ketamine's effectiveness in preventing post-spinal anesthetic shivering **(Natoli et al., 2021; Naz et al., 2021).**

The main aim of the study was to compare the effects of Tramadol and Ketamine in preventing post-spinal anesthesia shivering during lower limb surgeries.

Patients and methods

The study was a prospective clinical randomized trial conducted within the Anesthesia & Intensive Care department at Qena University Hospitals, South Valley University in Egypt. The primary involved one hundred adult patients who were scheduled for lower limb surgeries under spinal anesthesia. These patients were categorized into two distinct groups: group K, consisting of 50 patients who were administered post-spinal intravenous ketamine, and group T, comprising 50 patients who received tramadol.

Sample size calculation: This study base on study carried out by **Ameta et al., 2018** Epi Info STATCALC was used to calculate the sample size by considering the following assumptions:- 95% two-sided confidence level, with a power of 80%. & α error of 5%. The final sample size taken from the Epi- Info output was 50 in each group.

To be eligible for inclusion in the study, patients had to meet specific criteria. These criteria included being adults between the ages of 18 and 60 years, scheduled for lower limb surgeries under spinal anesthesia, and classified as ASA I or II in terms of physical status.

Conversely, certain exclusion criteria were established to ensure the integrity and safety of the study. Patients with hypersensitivity to the study medications, a history of alcohol or drug abuse, or any conditions associated with severe systemic diseases (such as cardiac, hepatic, renal, pulmonary, endocrinal, neurological, or psychiatric diseases) were not included. Additionally, individuals who had been prescribed opioid analgesics within a 24-hour period before the operation were excluded. Furthermore, patients who were taking medications known to influence thermoregulation, such as α-2 agonists, clonidine, betablockers, tricyclic antidepressants, or any similar drugs, were not part of the study. The study also

excluded patients using MAO inhibitors or adrenergic blockers, those with cognitive impairment, individuals with a recent history of febrile illness, and those with a history of malignant hyperthermia. Finally, patients classified as ASA III or IV were also excluded from the research.

Patients participating in this study were subject to a randomized allocation into two distinct groups. The primary objective was to compare the effects of administering ketamine with those of tramadol on post-operative outcomes among individuals undergoing lower limb surgeries within the post-operative care unit (PACU) of a university hospital. The patients were prospectively and randomly assigned to one of the following groups: Group K, consisting of 50 patients, who were given a dose of 0.25 mg/kg ketamine subsequent to spinal anesthesia, and Group T, which included 50 patients receiving a dose of 0.5 mg/kg tramadol following spinal anesthesia.

All patients received spinal anesthesia, during which 15 mg of hyperbaric Bupivacaine 0.5% was administered at either the L3/L4 or L4/L5 level, using a 22 G quince spinal needle under strict aseptic conditions. The drugs, both ketamine and tramadol, were diluted to a volume of 5 ml and were administered intravenously at a slow rate immediately after the intrathecal injection. Additionally, supplemental oxygen was provided via a face mask at a flow rate of 5 L/min throughout the surgical procedure.

After intrathecal injection the sensory and motor block were assessed with pinprick test. When spinal anesthesia was established the presence of shivering was assessed by:

A - shivering scale using a scale similar to that validated by **(Tsai and Chu, 2001), (Table.1)** where:

Table 1. Shivering scale (Tsai and Chu, 2001)

Grade	Clinical Signs
0	No Shivering
1	Piloerection or peripheral vasoconstriction but no visible shivering
2	Muscular activity in only one muscle group
3	Muscular activity in more than one muscle grou but not generalized
4	Shivering involving the whole body

If shivering occurred, it was graded and recorded and if the grade is 3 or 4 after 15 min from the administration of the tested prophylactic drug, it is considered severe shivering and rescue treatment in the form of IV 25 mg of pethidine was given.

B - And sedation scale: If patients were combative, very agitated, agitated, restless, alert and calm, drowsy, light sedation, moderate sedation, deep sedation and cannot be aroused **(Khan et al., 2012), (Table.2).**

Table 2. Sedation scale (Khan et al., 2012)

+4	**Combative**	**violent, immediate danger to staff**
+3	Very Agitated	Pulls or removes tube(s) or catheter(s); aggressive
+2	Agitated	Frequent non-purposeful movement, fights ventilator
+1	Restless	Anxious, apprehensive but movements not aggressive or vigorous
0	Alert & Calm	
-1	Drowsy	Not fully alert, but has sustained awakening to voice
-2	Light Sedation	Briefly awakens lo voice (eye opening & contact < 10 sec)

-3	Moderate Sedation	Movement or eye-opening to voice (but no eye contact)
-4	Deep Sedation	No response to voice, but movement or eye opening to physical stimulation
-5	Unarousable	No response to voice or physical

Heart rate, respiratory rate, mean arterial blood pressure and peripheral oxygen saturation (SpO2) were recorded using standard non-invasive monitors at 10 minutes intervals during the pre-and the post-anesthesia period. Any other side effects were recorded and properly treated e.g. hypotension, nausea, vomiting and hallucination.

The primary outcome of the study was to assess the impact of ketamine and tramadol on patients using shivering scale and sedation scale evaluations. Additionally, secondary outcomes involved investigating the effects of these drugs on patients' hemodynamics, including heart rate, blood pressure, and oxygen saturation levels, as well as monitoring for any potential complications that might arise during the course of the study.

Ethical approval: The research was granted an exemption from the research ethics committee of the Faculty of Medicine, South Valley University, code SVU-MED-AIP029-1-22-9-453

Statistical analysis

The data was presented using descriptive statistics, including mean and standard deviation for qualitative data representation, as well as numerical values and percentages for quantitative data representation. Group comparisons were performed using appropriate statistical tests, such as the Chi-Square test or Fisher's exact test for categorical data, the Mann-Whitney U test for continuous data that exhibited non-normal distribution, and the Student's t-test for continuous data that followed a normal distribution. Statistical significance was considered achieved when the p-value was less than 0.05.

Results

In the Ketamine Group (50 subjects), mean age was 36.28 years (SD 11.84, range 18-65). Tramadol Group (50 individuals) had mean age 31.46 years (SD 7.04, range 23-50). Significant age difference observed (p=0.01505*). Gender distribution: Ketamine - 58% male, 42% female; Tramadol - 68% male, 32% female (p=0.3004). Mean surgery duration: Ketamine 64.6 min (SD 7.62), Tramadol 61.8 min (SD 5.23), significant difference (p=0.0347). Shivering: 8% in Ketamine Group during surgery, none in Tramadol Group, but not statistically significant, (**Table.3**).

Table 3. Demographic and operation data of included subjects in both groups

Variables	**Ketamine Group (N = 50)**	**Tramadol Group (N = 50)**	**P. Value**
Age (Years)	40.4 ± 14.47	40.9 ± 14.98	0.8656
Sex			
• Male	29 (58%)	34 (68%)	0.3004
• Female	21 (42%)	16 (32%)	
Operation data			
Duration of Surgery (Minutes)	64.6 ± 7.62	61.8 ± 5.23	0.0347*
Shivering during surgery	4 (8%)	0	0.1175

*P<0.05 statistically significant

In the Ketamine Group (N = 50), no shivering at scale values 0-30. Shivering percentages: 14% at 40 min., 20% at 50 min., 26% at 60 min. Tramadol Group (N = 50) had no shivering across all scale values. Significant p-values for shivering at scales above 40 min.: 0.0125 at 40 min., 0.0012 at 50 min., 0.0001 at 60 min.

At 0 min, Ketamine Group RASS mean -0.9 (SD 0.51), Tramadol Group RASS 0. At 10 min RASS reached -0.54 ± 0.65 and at 20 min RASS reached -0.14 ± 0.35 in Ketamine group,. No significant RASS score at later times (30-60 min) for both groups was detected, with consistent RASS scores of 0 indicating no agitation or sedation (**Table.4**).

Table 4. Intraoperative follow up shivering occurrence in both study groups

Variables	Ketamine Group (N = 50)	Tramadol Group (N = 50)	P. Value
Shivering			
Shivering at 0	0	0	-
Shivering at 10	0	0	-
Shivering at 20	0	0	-
Shivering at 30	0	0	-
Shivering at 40	7 (14%)	0	0.0125*
Shivering at 50	10 (20%)	0	0.0012*
Shivering at 60	13 (26%)	0	0.0001*
RASS score			
RASS score at 0	-0.9 ± 0.51	0	-
	-1 (-2-0)		
RASS score at 10	-0.54 ± 0.65	0	-
	0 (-2-0)		
RASS score at 20	-0.14 ± 0.35	0	-
	0 (-1-0)		
RASS score at 30	0	0	-
RASS score at 40	0	0	-
RASS score at 50	0	0	-
RASS score at 60	0	0	-

*P<0.05 statistically significant

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) measured at various time points. At 0 min, Ketamine Group SBP: 130.58 mmHg (SD 10.59), Tramadol Group SBP: 126.6 mmHg (SD 10.49) - p=0.06195 (not significant). From 10 to 50 min, Ketamine Group consistently had lower SBP compared to Tramadol Group, p-values <0.0001* to 0.02711*. No SBP difference at 60 min **(Table.5, Fig.1).**

Table 5. Intraoperative follow up Blood and HR

Variables	Ketamine Group (N = 50)	Tramadol Group (N = 50)	P. Value
Blood pressure			
Systolic			
Systolic BP at 0	130.58 ± 10.59	126.6 ± 10.49	0.06195
Systolic BP at 10	124.92 ± 6.77	116.08 ± 10.87	<0.0001*
Systolic BP at 20	118.4 ± 7.32	114.44 ± 10.11	0.02711*

Systolic BP at 30	118.1 ± 7.34	113.14 ± 11.66	0.01247*
Systolic BP at 40	120.14 ± 8.75	116.4 ± 7.41	0.02315*
Systolic BP at 50	121 ± 7.19	117.26 ± 7.47	0.01228*
Systolic BP at 60	120.8 ± 9.66	118.78 ± 7.4	0.24328
Diastolic			
Diastolic BP at 0	76.48 ± 8.95	80.94 ± 8.01	0.01003*
Diastolic BP at 10	78.58 ± 7.41	68.88 ± 7.2	<0.0001*
Diastolic BP at 20	73.7 ± 6.23	69.9 ± 8.61	0.01305*
Diastolic BP at 30	71.98 ± 7.44	70.5 ± 9.68	0.39343
Diastolic BP at 40	72.06 ± 8.52	72.9 ± 5.74	0.56455
Diastolic BP at 50	74.28 ± 7.3	72.9 ± 4.59	0.26036
Diastolic BP at 60	72.08 ± 5.44	71.3 ± 3.35	0.38986
HR			
HR at 0	95.56 ± 14.67	92.24 ± 10.11	0.1908
HR at 10	97.5 ± 16.78	93.72 ± 8.29	0.15639
HR at 20	85.24 ± 15.97	92.06 ± 10.11	0.01226*
HR at 30	82.22 ± 10.85	92.16 ± 9.18	<0.0001*
HR at 40	80.96 ± 12.5	91.8 ± 9.53	<0.0001*
HR at 50	78.52 ± 12.09	90.28 ± 10.41	<0.0001*
HR at 60	79.38 ± 10.97	90.8 ± 7.46	<0.0001*

*P<0.05 statistically significant

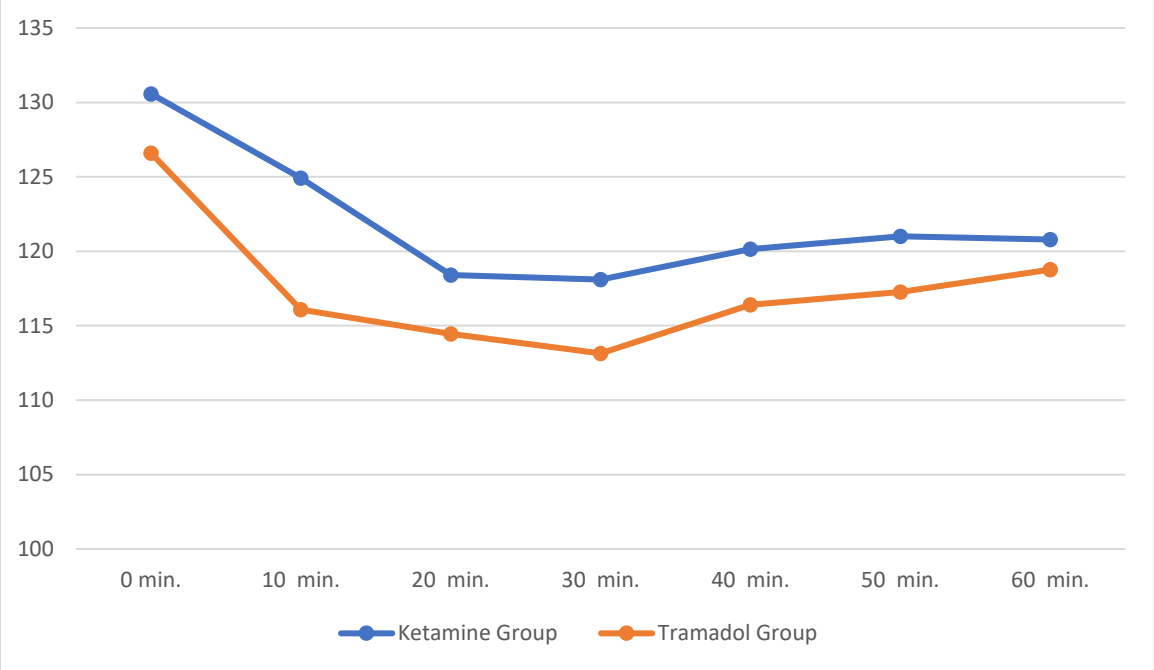

Fig.1. Intraoperative Systolic blood pressure in both study groups

For diastolic blood pressure, Ketamine Group had significantly lower DBP at 10, 20, and 50 min, p-values <0.0001*, 0.01305*, and 0.26036, respectively. No DBP difference at 0, 30, 40, and 60 min **(Fig.2).**

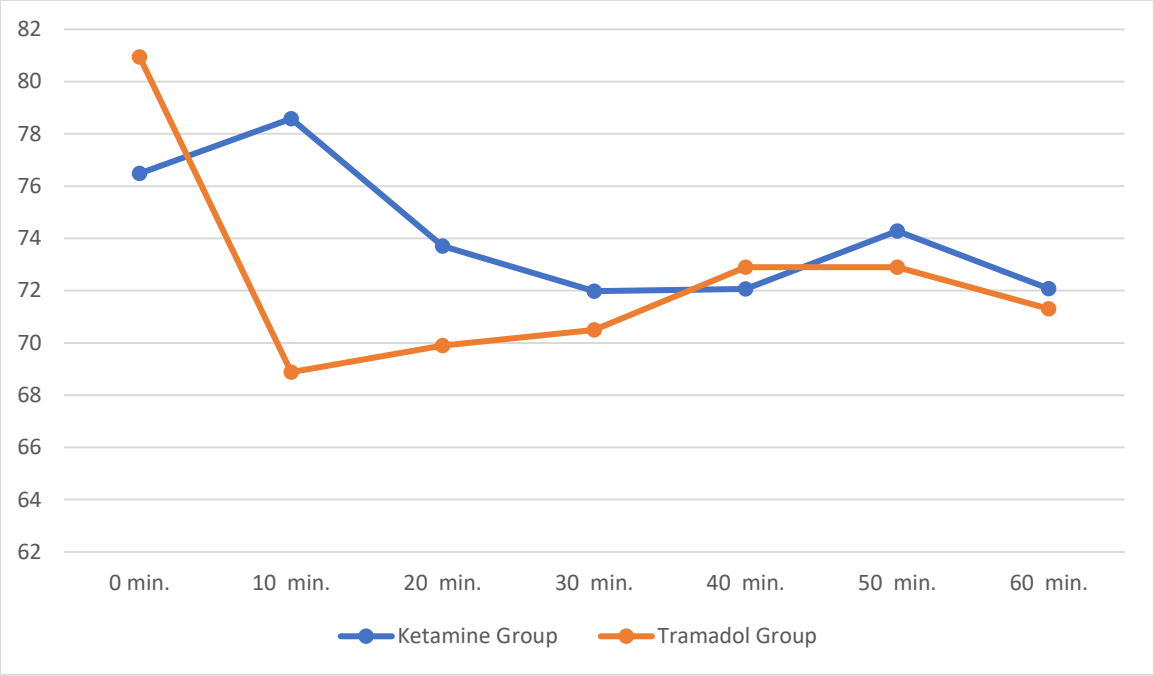

Fig.2. Intraoperative Diastolic blood pressure in both study groups

In the Ketamine Group (N = 50), heart rate (HR) at 0 min: 95.56 bpm (SD 14.67), Tramadol Group HR: 92.24 bpm (SD 10.11), p=0.1908 (not significant). From 10 to 60 min, Ketamine Group had significantly lower HR compared to Tramadol Group, p-values <0.05, with values of 0.01226* at 20 min and <0.0001* at 30, 40, 50, and 60 min **(Fig.3).**

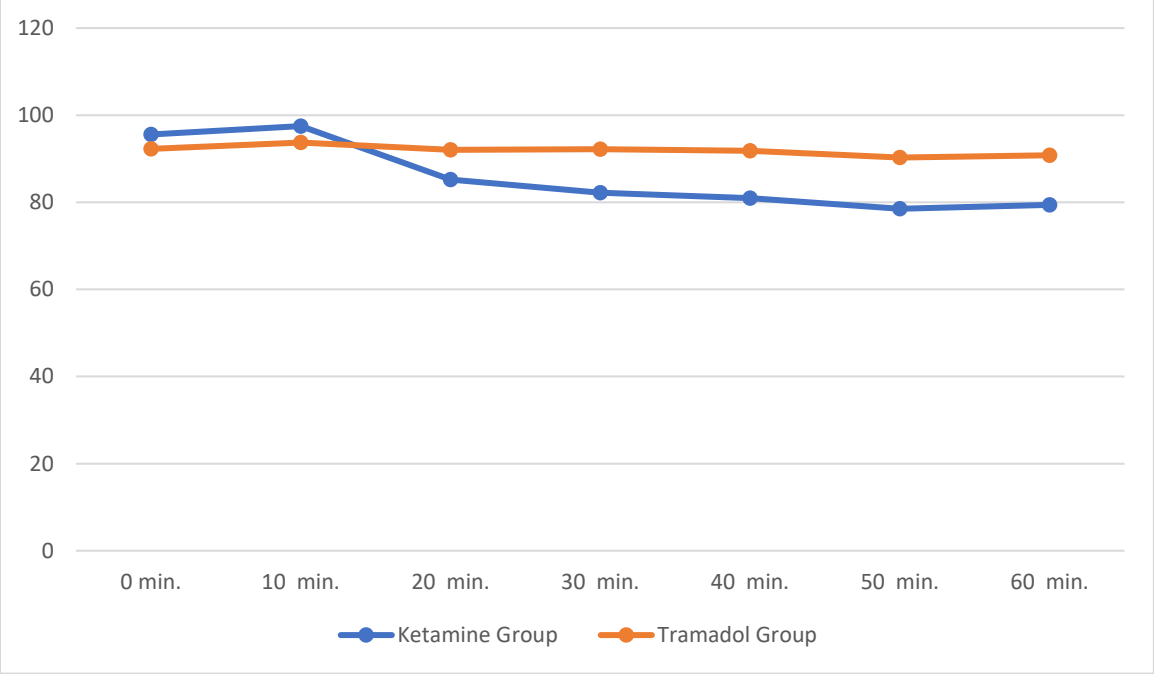

Fig.3. Intraoperative HR in both study groups

Oxygen saturation (SO2) measured at various times. At 0 min, Ketamine Group: 98.32% (SD 1.39), Tramadol Group: 99% (SD 1.36), p=0.01502* (significant

difference, Ketamine slightly lower). At 10-60 min, no significant differences in SO2 between groups, p-values 0.25115 to 0.71725 **(Table.6, Fig.4).**

Table 6.Intraoperative follow up SO2

Variables	Ketamine Group (N = 50)	Tramadol Group (N = 50)	P. Value
SO2			
SO2 at 0	98.32 ± 1.39	99 ± 1.36	0.01502*
SO2 at 10	99.18 ± 1.32	98.84 ± 1.67	0.26155
SO2 at 20	99.02 ± 1.53	98.9 ± 1.76	0.71725
SO2 at 30	99.12 ± 1.88	98.76 ± 1.73	0.32195
SO2 at 40	99.36 ± 1.54	98.7 ± 1.59	0.03753*
SO2 at 50	98.34 ± 1.66	98.6 ± 1.28	0.38251
SO2 at 60	99.48 ± 1.94	99.08 ± 1.5	0.25115
Respiratory Rate			
RR at 0	24.04 ± 1.4	21.86 ± 0.86	<0.0001*
RR at 10	22.98 ± 1.46	21.1 ± 1.18	<0.0001*
RR at 20	21.64 ± 1.79	20.22 ± 1.58	0.00006*
RR at 30	20.4 ± 2.02	19.46 ± 1.85	0.01718*
RR at 40	19.06 ± 2.33	18.58 ± 2.28	0.30049
RR at 50	18 ± 2.4	17.82 ± 2.58	0.71849
RR at 60	18 ± 2.4	17.82 ± 2.58	0.71849

*P<0.05 statistically significant

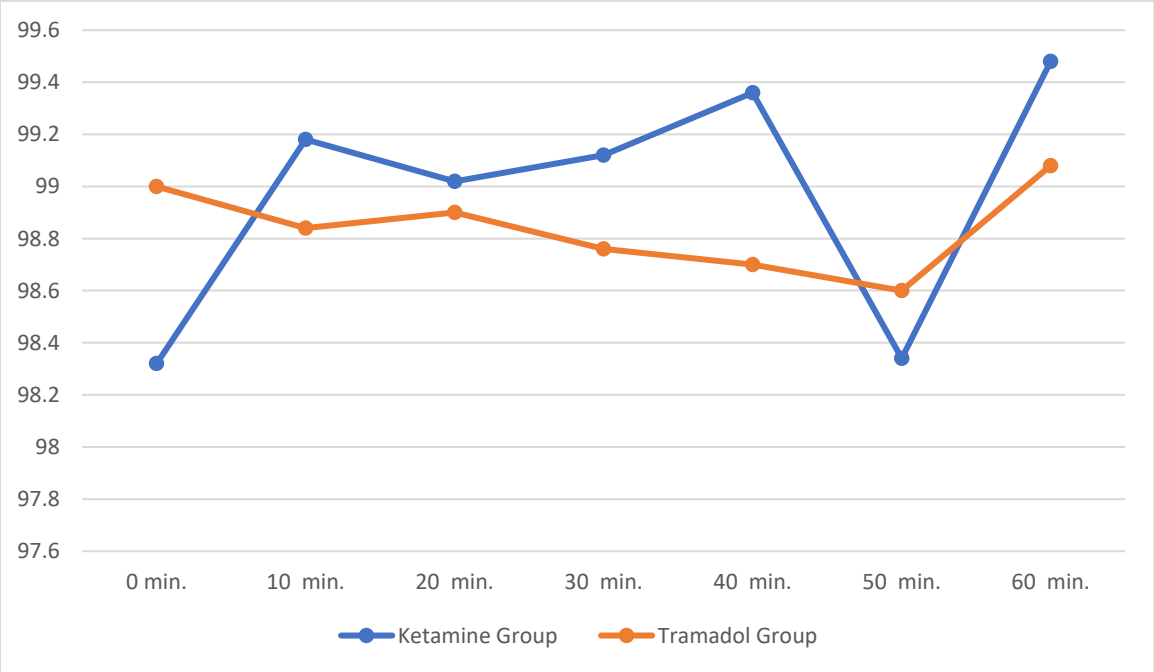

Fig.4. Intraoperative SO2 in both study groups

Respiratory rate (RR) measured at multiple times. At 0 min, Ketamine Group: 24.04 bpm, Tramadol Group: 21.86 bpm, p<0.0001* (significant difference, Ketamine higher). At 10-30 min, Ketamine Group RR remained significantly higher, p-values

<0.0001* at 10 min, 0.00006* at 20 min, and 0.01718* at 30 min. No significant RR differences at 40, 50, and 60 min, p-values 0.30049, 0.71849, and 0.71849 **(Fig. 5).**

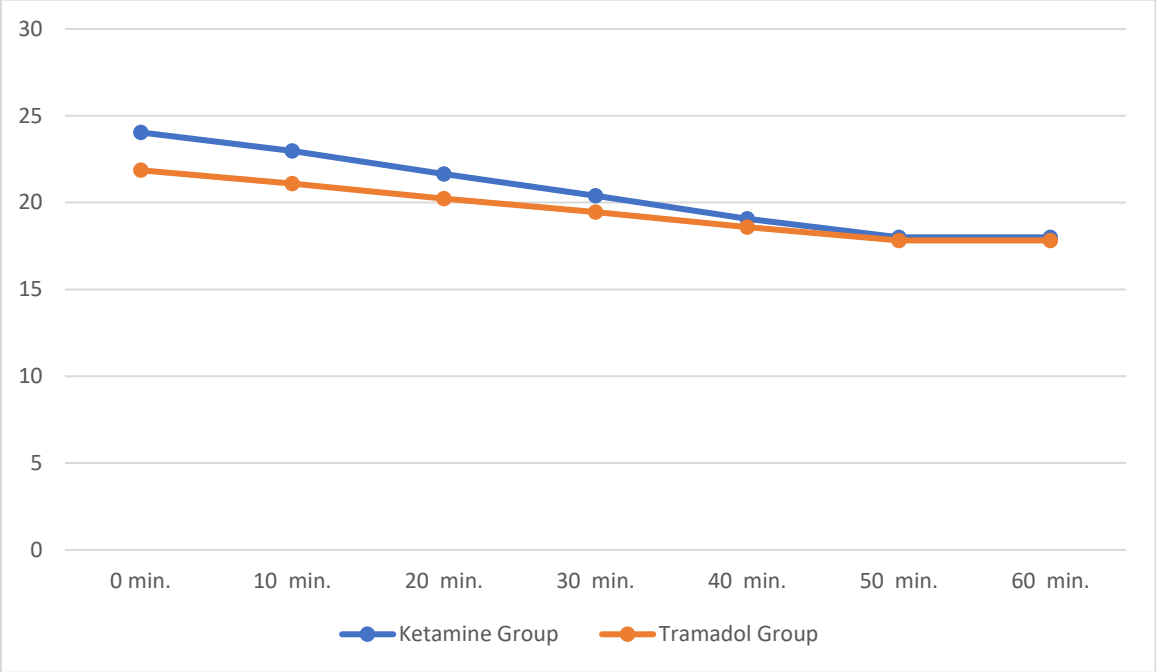

Fig.5. Intraoperative SO2 in both study groups

Discussion

Our study aligns with **Askri et al. (2020),** which assessed ketamine and tramadol for preventing intraoperative shivering during lower limb surgeries under spinal anesthesia. Three groups (30 patients each): Group S (IV normal saline), Group T (IV tramadol 0.5mg/kg), Group K (IV ketamine 0.5mg/kg). Median ages: Group S 43, Group T 45, Group K 45; age range 18-60. Gender distribution: similar (Group S: 23 males, 7 females; Group T: 23 males, 7 females; Group K: 24 males, 6 females).

Similarly, **Ameta et al. (2018)** assessed ketamine, dexmedetomidine, and tramadol for preventing shivering after spinal anesthesia. Four groups: Group K (ketamine), Group T (tramadol), Group D (dexmedetomidine), Group C (normal saline). No significant age differences (p=0.58) or gender differences (p=0.612) among groups.

In our study, Ketamine Group had longer surgery duration (64.6 min) than Tramadol Group (61.8 min), with significant difference (p=0.0347*). Ketamine's dissociative effects may make surgery feel longer, while tramadol's pain control may shorten perception. Patient factors and time perception also play a role **(Paladini et al., 2023; Yang et al., 2020).**

Askri et al. (2020) supported our findings; Group T (tramadol) had shortest surgery (78.0 min), while Groups S (saline) and K (ketamine) were slightly longer (80.3 min and 79.9 min). Tramadol seemed to reduce surgery duration.

Against our results, **Ameta et al. (2018)** found no significant surgery duration differences (p=0.149) among groups: Group K 67.2 ± 9.3 min, Group T 60.8 ± 15.0 min, Group C 63.8 ± 15.3 min, Group D 63.6 ± 14.7 min. This contrasts with our study, suggesting prophylactic agents may have variable effects in different patient populations or settings.

Our study found that immediately postoperatively (at 0 min), Ketamine Group

had significantly lower Richmond Agitation-Sedation Scale (RASS) scores compared to Tramadol Group ($p<0.0001$*). No significant sedation differences at 10-60 minutes; both groups maintained RASS scores of 0, indicating no agitation or sedation. Ketamine's dissociative properties explain the initial difference.

Along with our results, **Gemechu et al. (2022)** reported higher intraoperative sedation in the ketamine group vs. tramadol group ($p=0.001$). **Wason et al. (2012)** also found higher sedation scores in the ketamine group, consistent with our results.

In contrast, **Vinathi et al. (2018)** found ketamine and tramadol had higher sedation scores than dexamethasone, possibly due to different premedications. **Sriranganath et al. (2020)** reported similar initial sedation at 0 and 10 minutes, but at 20-30 minutes, ketamine induced more significant sedation compared to tramadol and control groups ($P<0.05$). Tramadol and control groups maintained consistent sedation ($P>0.05$). No Grade IV sedation occurred, indicating both tramadol and ketamine can induce sedation without excessive sedation or agitation.

In our study, significant heart rate (HR) and blood pressure differences were observed. Ketamine Group had consistently lower HR at 10-60 minutes. For systolic blood pressure (SBP), Ketamine Group had lower values at 10-50 minutes, and for diastolic blood pressure (DBP), differences at 10, 20, and 50 minutes. Tramadol had milder cardiovascular impact.

Gemechu et al. (2022) found similar hemodynamic changes with higher arterial blood pressure in the ketamine group. **Lakhe et al. (2017)** reported elevated arterial blood pressure with ketamine, supporting our findings.

Askri et al. (2020) and **Nazir et al. (2015)** showed no significant baseline vital sign differences among groups before treatments, suggesting similar baseline conditions. Possible reasons include pre-warmed IV fluid and ketamine's sympathomimetic action.

In out study at 0 minutes, the Ketamine Group exhibited lower SO2 (oxygen saturation) than the Tramadol Group, with mean SO2 of 98.32% (SD = 1.39) vs. 99% (SD = 1.36), a statistically significant difference ($p = 0.01502$*). However, SO2 levels became similar in both groups from 10 to 60 minutes.

The Ketamine Group showed significantly higher RR (respiratory rate) at 0 minutes and from 10 to 30 minutes ($p < 0.0001$* to 0.01718*) compared to the Tramadol Group. However, no significant RR differences were observed at 40, 50, and 60 minutes, indicating comparable respiratory rates in later stages of surgery.

Notably, **Nazir et al. (2015)** reported no oxygen desaturation episodes in their study, regardless of the treatment received (normal saline, ketamine 0.5 mg/kg, or tramadol 0.5 mg/kg). Similarly, **Askri et al. (2020)** found no respiratory rate abnormalities or adverse events in their groups, including those receiving normal saline, tramadol, or ketamine.

Shivering during surgery was more common in the Ketamine Group (8% vs. 0% in the Tramadol Group), although the difference was not statistically significant.

Our findings were congruent with **Gemechu et al. (2022),** who found that 28.7% of ketamine patients and 43.8% of tramadol patients had intraoperative shivering. These percentages show that both groups shivered, especially the tramadol group. Our investigation found no statistically significant difference between the two groups, supporting Gemechu et al.

In a mixed patient population, **Shakya et al. (2010)** found 18.75% in the ketamine group and 46.88% in the tramadol group. Shivering was also seen in both

groups, with tramadol recipients having a greater rate. Like Shakya et al., our investigation found no statistically significant difference between the two groups.

Lema et al. (2017) found 41.5% shivering in the ketamine group and 53.7% in the tramadol group, with a higher frequency in the tramadol group. Our analysis confirms this tendency of increased shivering in the tramadol group, although statistical significance is still lacking.

Ahmed et al. (2018) found that tramadol (6%) caused less shivering than ketamine (32%). Ahmed et al.'s trial included preventive medicines and pre-warmed intravenous fluid, which may have decreased shivering in the tramadol group. We must accept that this study's results vary from ours and the other research, suggesting that many circumstances may affect shivering occurrence.

Gupta et al. (2018) compared 20 mg (G T20) and 10 mg (G T10) tramadol to a placebo (GP) to determine its anti-shivering efficacy. Their investigation found that tramadol T10 (20%) and T20 (6.67%) reduced shivering incidence compared to placebo (53.33%), with G T20 having the lowest incidence (6.67%), similar to our data (4.6%).

In contrast, **Badhe et al. (2019)** and **Bansal et al. (2020)** compared 20 mg tramadol against a placebo and found 0% and 6.66% shivering, respectively. Our study's findings match Gupta et al.'s, showing a similar shivering incidence, but Badhe et al. and Bansal et al.'s tramadol groups had 0% to 6.66% and 5%, respectively. These differences may be due to patient demographics, tramadol doses, or research circumstances.

In this research, the Ketamine Group experienced no shivering during the first 30 minutes but increased significantly between 40 and 60 minutes, with percentages ranging from 14% to 26%. The Tramadol Group had no reported shivering at any time, a statistically significant difference.

Tramadol prevented intraoperative shivering better than Ketamine. The anti-shivering action of Tramadol is due to its μ receptor agonist activity. It decreases spinal cord serotonin, norepinephrine, and 5-hydroxytryptamine (5-HT) reuptake and releases 5-HT. It helps regulate temperature. Tramadol prevents intraoperative shivering better than Ketamine, suggesting it may be a better preventive drug **(Zeb et al., 2021; Edinoff et al., 2021).**

Our investigation confirmed **Askri et al. (2020),** who found substantial differences in shivering occurrences at various post-anesthesia times in three groups given normal saline, tramadol, and ketamine intravenously. With p-values < 0.001, shivering occurrences differed considerably at T5, T10, and T20 post-anesthesia, with ketamine having the greatest incidence. The groups were comparable at T30 because the differences in shivering incidence were not statistically significant ($p = 0.088$).

Recommendations: Investigate Drug Efficacy: Research Tramadol's effectiveness in preventing shivering after spinal anesthesia during lower limb surgeries through large-scale trials. Customize Prophylactic Measures: Tailor shivering prevention strategies based on individual patient factors (age, comorbidities) and surgical context (type of surgery). Choose between Tramadol and Ketamine accordingly. Assess Long-Term Outcomes: Extend assessments beyond immediate post-surgery to understand how Tramadol and Ketamine impact recovery, patient satisfaction, and surgical outcomes. Monitor Adverse Events: Vigilantly track side effects (nausea, vomiting, hallucinations) associated with Tramadol and Ketamine use for informed safety decisions. Develop Evidence-Based

Guidelines: Create guidelines based on accumulating research, aiding healthcare providers in selecting prophylactic agents prioritizing patient safety and comfort. Prioritize Patient Involvement: Involve patients in choosing prophylactic agents to enhance perioperative experience and overall satisfaction. Comparison with other opioids and substances as pethidine.

Conclusion

Tramadol emerged as the more effective prophylactic agent, significantly reducing the occurrence of shivering during surgery and demonstrating favorable outcomes in terms of sedation levels and the impact on cardiovascular and respiratory parameters.

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