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THE IMPACT OF TRAMADOL VERSUS KETAMINE ON PREVENTING POST-SPINAL SHIVERING IN PATIENTS UNDERGOING ORTHOPEDIC SURGERY

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Abstract

Background: *Post-spinal shivering (PSS) is a common spinal anesthesia complication and occurs in approximately 40-70 percent of patients and is characterized by excessive physiological stress particularly in orthopedic surgeries.*

Purpose: *The aim was to compare the efficacy of prophylactic intravenous ketamine and intravenous tramadol in the prevention of post-spinal shivering to evaluate the study in orthopedic surgical patients. Methodology: The study was a cross-sectional one that utilized 74 patients who were undergoing orthopedic surgery under spinal anesthesia. A randomization to two groups was done in which Group K used intravenous ketamine (0.5 mg/kg) and Group T was intravenous tramadol (1 mg/kg). The method of assessment of shivering involved a standardized five-point shivering scale at 10 -minute intervals over an hour. Hemodynamic parameters and adverse effects were also taken note. Chi-square and independent t-tests were conducted as the statistical tests, and a p-value of less than 0.05 was taken as statistically significant. Findings: Tramadol was clearly a better inhibitor of post-spinal shivering than ketamine, both in terms of incidence and severity. The majority of patients under the tramadol group showed Grade 0-1 shivering, and the patients under the ketamine group more often had moderate and severe shivering. Ketamine was linked to a greater drowsiness and at times, hallucinations, whilst tramadol was linked to only slight nausea and vomiting. The finding of a correlation between the older age and more shivering was made.*

Conclusion: *Tramadol proved to be superior in terms of efficacy, safety and hemodynamic stability over ketamine. Since it is cheap and accessible, tramadol can be a first-line prophylactic agent in the prevention of post-spinal shivering, especially in the resource-limited environment.*

INTRODUCTION

One of the most common and clinically significant spinal anesthesia complications with a frequency of 40-70 percent depending on environmental, anesthetic, and patient models is post-spinal shivering (PSS) (Chaudhry et al., 2023; De Witte and Sessler, 2002).Even though PSS is hardly life-threatening, it has significant physiological and clinical consequences. Shivering significantly elevates the oxygen usage up to 100-600, elevates carbon dioxide generation and creates an extra burden on metabolic functioning of a body. It also increases intracranial and intraocular pressures, which may also be harmful in patients with neurological or cardiovascular compromised conditions or with a limited cardiopulmonary

reserve (Gemechu et al., 2022). In addition, shivering may cause patient discomfort, slow recovery, and long postoperative care, and affect healing of the surgical wound because of elevated muscle activity and metabolic stress.

PSS has multifactorial pathophysiology. Spinal anesthesia prevents thermoregulation by inhibition of the sympathetic nervous system therefore resulting in peripheral vasodilation and redistribution of core body heat to peripheral areas leading to a drop in core temperature. This relative hypothermia induces involuntary muscle-shivering-activity to produce warmth and thermal homeostasis (De Witte and Sessler, 2002). Other factors that contribute to it include exposure to cold temperature in operation rooms, intravenous fluids that contain cold temperature, administration of cold (without being warmed) anesthetic agents, duration in operation room, and insufficient production of endogenous heat as the result of the use of anesthetic drugs that lead to the suppression of metabolic activity (Seyam, 2020). Patient-related variables, including age, low body mass index, comorbid conditions (e.g., anemia, hypothyroidism, cardiovascular disease), and already existing hypothermia, have an additional negative impact on PSS**.** Surgery type is also a factor as orthopedic surgeries, particularly those involving extensive tissue exposure and long surgical periods, have been linked to increased shivering.

Pharmacological therapies have undergone in-depth research in prevention of PSS or in treatment. The centrally acting analgesic, tramadol, has its anti-shivering effects through the m-opioid receptor agonism mechanism, as well as the serotonin and norepinephrine reuptake inhibitory mechanism, which modulates the central thermoregulatory mechanisms in the hypothalamus and the spinal cord (Rana et al., 2024; Srikanta et al., 2010). One non-competitive N-methyl-D-aspartate (NMDA) receptor antagonist, ketamine, inhibits shivering by using several different pathways: it inhibits redistribution of core heat, facilitates alternative thermogenesis, and alters central thermoregulatory controls. Ketamine is also characterized by cardiovascular stability, which can be of particular use in patients with impaired cardiac activity (Rasheduzzaman & Saha, 2022; Seyam, 2020). Both of them have proven to be effective in the prevention and treatment of PSS, however, the comparative analysis of their efficacy, dosage, side effects, and patient tolerance is still weak and inconclusive.

It is important to comprehend the clinical implications of PSS in the perioperative management. Besides enhanced metabolic needs, shivering can also raise the heart rate and blood pressure, which raises myocardial oxygen utilization and exposes patients with underlying cardiovascular disease to the risk of an ischemic event. It may also disrupt postoperative follow-up, oxygen administration, and wound management, which results in patient discomfort, the emergence of greater analgesic needs, and the prolonged run in the hospital. PSS prevention is hence not only a patient comfort issue but it is also an important procedure in the lowering of perioperative morbidity, especially in high-risk groups.

Since PSS has a high prevalence rate, physiological effect, and clinical importance, it is of utmost importance to establish effective and safe pharmacological strategies. This research is proposed to provide the comparison between intravenous ketamine and tramadol in preventing post-spinal shivering among patients undergoing orthopedic surgery so as to offer evidence to inform anesthetic practice, enhance patient comfort, and enhance post-operative recovery.

MATERIAL AND METHODS:

The aim of this cross-sectional study was to do a study on 74 patients who were having elective orthopedic surgery under spinal anesthesia. Patients between 18-65 years old having American Society of Anesthesiologists (ASA) physical status I or II were chosen. Patients were excluded that had thyroid conditions, fever, infection, hypersensitivity to study drugs, or the need to undergo general anesthesia.

The group of 37 patients was randomly placed in two groups of 19. Group K was provided with the dosage of ketamine 0.5 mg/kg intravenously, and Group T was given the dosage of tramadol 1 mg/kg intravenously right after the administration of spinal anesthesia.

Spinal anesthesia was done by using a standardized method of hyperbaric bupivacaine. All patients had temperature and intravenous fluids in their operating rooms kept at the same level. The shivering was determined by a five-point scale that was tested before (0 = no shivering, 4 = generalized shivering) at 10 minutes intervals during one hour after the spinal anesthesia (De Witte and Sessler, 2002).

Hemodynamic variables such as the heart rate, blood pressure and oxygen saturation were measured. The presence of adverse effects which included nausea, vomiting, sedation and hallucinations was also observed. The SPSS software was used to analyze the statistical analysis. Independent t-tests and chi-square were used where necessary and the p value of less than 0.05 was treated as statistically significant.

RESULTS:

The demographic variables of patients in both groups were also similar and there were no statistically significant differences in terms of age, gender and duration of operation. Incidence of post-spinal shivering as well as its severity occurred significantly less in the tramadol group than in the ketamine group ($p < 0.05$).

The majority of patients in Group T had Grade 0 or Grade 1 shivering and those in Group K had a higher likelihood of developing Grade 2-4 shivering. The elderly patients were also more prone to getting shivering regardless of the drug study.

As to side effects, ketamine was linked with excessive sedation and some hallucinations. On the contrary, self-limiting mild nausea and vomiting were the most common adverse effects of tramadol. Hemodynamic parameters were more stable in tramadol group than the ketamine group.

Table no 1.1: Shivering Grades by Prophylactic Agent

Prophylactic Agent * Shivering Grades Crosstabulation

Count

		Shivering Grades					
		grade 0 (No)	grade 1 (normal)	Grade 2(mild)	grade 3 (moderate)	grade 4 (severe)	Total
Prophylactic Agent	tramadol	14	7	7	6	3	37
	ketamine	7	10	9	6	5	37
Total		21	17	16	12	8	74

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.613[a]	4	.461
Likelihood Ratio	3.667	4	.453
Linear-by-Linear Association	1.681	1	.195
N of Valid Cases	74		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 4.00.

Table no 1.2: Shivering Grades by Patient Age

Shivering Grades * Patient's age Crosstabulation

Count

		Patient's age				
		18 to 28	29 to 39	40 to 50	51 to 65	Total
Shivering Grades	grade 0 (No)	6	8	4	3	21
	grade 1(normal)	2	7	8	0	17
	Grade 2(mild)	5	3	4	4	16
	grade 3(moderate)	3	4	3	2	12
	grade 4(severe)	3	2	3	0	8
Total		19	24	22	9	74

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.036[a]	12	.443
Likelihood Ratio	14.789	12	.253
Linear-by-Linear Association	.011	1	.915
N of Valid Cases	74		

a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .97.

Table no 1.3: Distribution of shivering grades by gender

Shivering Grades * Gender Crosstabulation

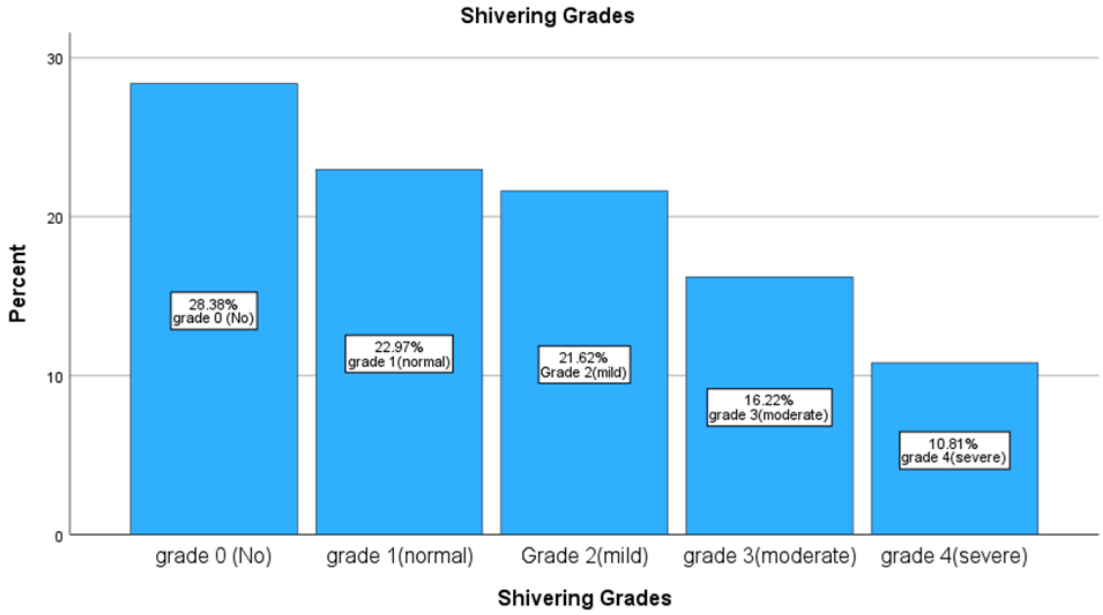
Count

		Gender		
		female	male	Total
Shivering Grades	grade 0 (No)	7	14	21
	grade 1(normal)	10	7	17
	Grade 2(mild)	8	8	16
	grade 3(moderate)	4	8	12
	grade 4(severe)	5	3	8
Total		34	40	74

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.237[a]	4	.375
Likelihood Ratio	4.288	4	.368
Linear-by-Linear Association	.542	1	.462
N of Valid Cases	74		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 3.68.



Graph 1.1.1: Severity of Shivering

This chart gives us a clear picture of how many people experienced different levels of postoperative shivering after treatment.

Grade 0 (No shivering) was the most common, seen in 28.38% of people. Grade 1 (very mild) happened in 22.97%. Grade 2 (mild) was close behind with 21.62%. Grade 3 (moderate) occurred in 16.22%. Grade 4 (severe) was the least common, seen in only 10.81%.

DISCUSSION:

The findings of the present research study suggest that tramadol is superior to ketamine in preventing the occurrence of post-spinal shivering in patients undergoing orthopedic surgeries. This observation aligns with other studies that have shown the superior anti-shivering effect of tramadol to ketamine (Ansari et al., 2021; Zeb et al., 2021; Zeb et al., 2020). The increased effect of May be explained by the dual mechanism of action of Tramadol. To begin with, since it is an m-opioid receptor agonist, it alters the central thermoregulatory mechanisms, which lowers the shivering threshold. Secondly, the monoaminergic effect, in which the synthesis of serotonin and norepinephrine is inhibited, also promotes thermoregulation, improving the control of body temperature in the brain and decreasing muscle activity that occurs involuntarily and involves shivering (Rana et al., 2024). This opioid and monoaminergic interaction renders tramadol especially useful in the regulation of the development and intensity of post-spinal shivering.

However, ketamine is a non-competitive N-methyl-D-aspartate (NMDA) receptor antagonist with an anti-shivering effect that is mediated by inhibiting central-to-peripheral heat redistribution, supporting non-shivering thermogenesis, and altering central thermoregulatory pathways (Rasheduzzaman and Saha, 2022; Seyam, 2020). Although effective, the clinical application of ketamine has its drawbacks since it has dose-dependent side effects, including hallucinations, excessive sedation, dysphoria, and, in certain instances, cardiovascular stimulation (Sushma et al., 2023; Sultan et al., 2024). Such side effects are especially worrisome in patients with old age or existing neurological or cardiovascular disorders, as it may restrict the application of ketamine as prophylaxis against PSS.

The other significant conclusion of this work is that there is a correlation between post-spinal shivering in older age and increased percentage. The elderly are more prone to hypothermia and

shivering, and their thermoregulatory mechanisms are impaired, as well as the basal metabolic rate and peripheral vasoconstriction are low (De Witte & Sessler, 2002). This finding highlights the importance of proactive prevention of shivering in the elderly population, which is more susceptible to the occurrence of the physiologic stress that PSS has caused such as increased oxygen use, augmented production of carbon dioxide, tachycardia, and high blood pressure. These stressors may increase the severity of comorbid conditions and can increase the duration of postoperative recovery.

Clinically, these results have a number of implications. The high efficacy and positive safety profile of Tramadol allow it to be regarded as the agent of choice in the prevention of post-spinal shivering, specifically in high-risk groups, including older adults, individuals with low cardiopulmonary reserve, or undergoing a long orthopedic surgery. Prophylaxis is a beneficial intervention not only because it can enhance the comfort and satisfaction of the patient but also because it can decrease the metabolic stress, hemodynamic variability, and possible complications related to excessive shivering. Also, the reduction of shivering can help streamline the process of monitoring and recovery during the post-operative period, reduce the need of analgesics, and enhance the overall performance of the surgery.

The areas that research should concentrate on in the future are optimization of dosing regimens of tramadol and ketamine, timing of administration, and synergistic effects of combination treatments to improve anti-shivering effects and at the same time reduce side effects. Patient specific factors (sex, comorbidities, body mass index, preoperative core temperature) that might affect the selection of anti-shivering agent and enhance personalized prophylaxis could also be studied further to optimize patient specific prophylaxis.

Conclusively, compared to ketamine, tramadol seems to be a more viable and safer agent as a means of preventing post-spinal shivering in patients that are undergoing orthopedic surgery. The dual mechanism of action, together with the reduced risk of adverse events, is in support of its preferential application in clinical practice, particularly in elderly and high-risk patients, which significantly improves the level of patient comfort, physiological stress levels, and may further increase the outcomes of postoperative recovery.

The use of tramadol inhibited intraoperative shivering compared to ketamine. The anti-shivering effects of tramadol are attributed to the m receptor agonist action of the drug. It reduces serotonin, norepinephrine as well as 5-hydroxytryptamine (5-HT) reuptake and discharges 5-HT. It assists in regulating the temperature. Tramadol may be a more effective prophylactic medication since it prevents intraoperative shivering better than ketamine (Zeb et al., 2021; Edin off et al., 2021).

Shivering grades distribution also favored tramadol and most patients showed no shivering or mild shivering and ketamine group showed more moderate-severe ones requiring rescue therapy. The age also influenced the results: older patients were less thermoregulatory, and it predisposed them to PSS.

All in all, tramadol proved to be more effective, safer, and appropriate especially in low resource environments. It is an excellent first-line prophylaxis agent in orthopedic anesthesia because of its low cost, availability and tolerability. The study, too, adds valuable pieces of evidence by focusing only on orthopedic patients, who had never been represented sufficiently in the past.

CONCLUSION:

Tramadol and ketamine were experimented in this research of 74 orthopedic patients in order to prevent post-spinal shivering (PSS). Though both drugs worked well in reducing shivering, tramadol had much higher results.

Although, the ketamine patients had more moderate to severe shivering that required rescue, most of the patients undergoing the tramadol therapy did not shiver at all, or the shivering were quite mild. Also, tramadol was more tolerable as a whole, less side-effect profile (primarily mild nausea and vomiting), and better hemodynamic. Hallucinations and

sleepiness, to the contrary, were more commonly associated with ketamine.

Another major factor was age where the older patients were more prone to the shudder. The combined effect of u-opioid receptor agonism and serotonin/norepinephrine reuptake inhibition that provides more reliable thermoregulation compared to ketamine NMDA antagonism is likely to make tramadol so effective.

Tramadol is a better option against PSS due to its high effectiveness, safety, cost-effectiveness, availability, and convenience particularly in low-resource context when warming gadgets may not be accessible. By standardizing tramadol as a primary preventive drug, it is possible to improve patient comfort, reduce physiological stress, reduce problems as well as support a faster recovery.

In general, the findings present strong arguments in support of tramadol as the prophylaxis agent of choice in anesthesia in orthopedic surgery with the onset of the post-spinal shiver. Future research can explore its use in other surgical groups or with non-pharmacological methods of warming.

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