Original Article

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Comparison of Palonosetron with Ondansetron in Prevention of Postspinal Shivering: A Randomised Controlled Trial

Anaesthesia Section

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ABSTRACT

Introduction: Postspinal shivering is a frequent and distressing complication following spinal anaesthesia due to impaired thermoregulation that leads to redistribution of body heat, resulting in hypothermia, increased metabolic demand, and patient discomfort. Uncontrolled shivering can contribute to haemodynamic instability and increased oxygen consumption, which can be detrimental in vulnerable patients. Along with shivering, Postoperative Nausea and Vomiting (PONV) are common postoperative concerns that affect patient recovery and satisfaction. Therefore, effective prophylactic strategies targeting both shivering and PONV are crucial in improving perioperative outcomes.

Aim: The present study aimed to compare the efficacy of prophylactic palonosetron versus ondansetron in preventing postspinal shivering and PONV among patients posted for lower limb orthopaedic surgeries under spinal anaesthesia.

Materials and Methods: The present double-blinded, randomised controlled trial was conducted at SRM Medical College and Hospital Research Centre, Chennai, Tamil Nadu, India, involving 138 adult patients scheduled for elective lower limb orthopaedic surgeries. Patients were randomly allocated into three groups, each comprising 46 participants. Group P received 0.075 mg of intravenous palonosetron, Group O received 8 mg of intravenous ondansetron, and Group C received 5 mL of intravenous normal saline. All study drugs were administered 30 minutes before spinal anaesthesia. The study assessed haemodynamic parameters, the incidence and severity of shivering, and the incidence and severity of PONV at specified intraoperative and postoperative time intervals. Statistical analysis was performed using One-way Analysis of Variance (ANOVA) for continuous variables and the Chi-square test for categorical data.

Results: Baseline demographics and haemodynamic data were comparable among the groups. Palonosetron was significantly more effective in reducing both the incidence and severity of shivering compared to ondansetron. At 15 minutes, Grade 2 shivering was recorded in 43.48% of Group C, 15.22% of group O, and 6.52% of group P ($p<0.0001$). A similar trend persisted at 45 minutes. By 60 minutes, shivering incidence declined across all groups without significant differences. Palonosetron also outperformed in reducing intraoperative nausea, particularly between 45-60 minutes, while vomiting rates were low and comparable. The overall incidence of PONV was significantly lower in the palonosetron group ($p<0.0480$).

Conclusion: Prophylactic i.v. palonosetron is superior to ondansetron in preventing postspinal shivering and PONV, enhancing perioperative patient comfort and safety.

Keywords: Haemodynamic instability, Hypothermia, Lower limb orthopaedic surgeries, Serotonin 5 HT 3 receptor antagonists, Thermoregulation

INTRODUCTION

Spinal anaesthesia, referred to as subarachnoid block, is a neuraxial regional anaesthesia technique that serves as a safe and effective alternative to general anaesthesia for surgeries involving the lower extremities and procedures below the umbilicus [1]. Spinal anaesthesia is administered as a single injection of local anaesthetic or opioid into the subarachnoid space using a spinal needle, which delivers the anaesthetic directly into the cerebrospinal fluid, ensuring rapid onset and effective regional blockade. This technique allows for precise dosing, optimising pain management while minimising patient discomfort [2].

Spinal anaesthesia is commonly associated with transient haemodynamic adverse effects, such as shivering, hypotension and bradycardia. The incidence of postspinal anaesthesia shivering has been reported to range between 40% and 60% [3]. Shivering can double or even triple oxygen consumption and carbon dioxide production and induce lactic acidosis and catecholamine release, resulting in increased cardiac output, Heart Rate (HR) and Mean Arterial Pressure (MAP) [4]. Shivering may also contribute to heightened adrenergic and sympathetic activity, potentially leading to organ dysfunction, including myocardial ischemia [4]. Shivering, apart from causing psychological stress to the patient, also interferes with patient monitoring such as Electrocardiogram (ECG), Non-Invasive Blood Pressure (NIBP), and peripheral Oxygen Saturation (SpO_2) [5]. Furthermore, it can cause significant patient discomfort and has been associated with an increased risk of postoperative complications such as infection, pain, and bleeding. Shivering may impair wound healing and prolong hospital stay. Therefore, suppressing shivering in hospitalised patients is an essential measure to enhance patient comfort and mitigate shivering-related complications [6].

Both pharmacological and non-pharmacological methods have been studied for the prophylaxis of perioperative shivering. Non-pharmacological methods include the use of forced warm air blankets, airway heat and moisture exchangers and prewarming [7]. Pharmacological agents reduce shivering by increasing the temperature threshold. Various agents used for this purpose include pethidine, tramadol, clonidine, and ketamine [7]. These agents have the potential to cause excessive sedation, respiratory depression, nausea, vomiting and itching. The use of ondansetron and palonosetron can reduce these complications to some extent. PONV affects 25-30% of patients after anaesthesia and surgery, leading to delayed recovery, increased healthcare costs, and reduced patient satisfaction. Signals from the CTZ and other systems are integrated in the medullary vomiting centre, triggering emesis [7].

A 5-Hydroxytryptamine subtype 3 receptor (5-HT3) antagonist given prophylactically is effective in reducing the incidence of postspinal shivering and PONV [8]. The advantages of 5-HT3 antagonists are

minimal sedation, lack of dysphoria and extrapyramidal side-effects, a relative safety profile and simultaneous prophylaxis against PONV. The commonly used 5-HT3 antagonists include ondansetron, palonosetron. These agents differ from each other by their relative potency and duration of action [8,9]. Although 5-HT3 receptor antagonists are known for their anti-shivering and antiemetic properties, there remains a notable gap in the literature regarding their comparative efficacy in preventing postoperative shivering and PONV following spinal anaesthesia. In particular, evidence on the effectiveness of these agents at lower doses is limited. To address this gap, the present prospective, randomised, double-blind study was designed to evaluate and compare the efficacy of low-dose ondansetron and palonosetron in reducing the incidence and severity of postspinal shivering and PONV. The present study compared the efficacy of palanosetron and ondansetron in reducing postspinal shivering and PONV. The primary objective of this study was to compare the incidence of postspinal shivering between low-dose ondansetron and palonosetron. The secondary objectives included comparing the severity of postspinal shivering, evaluating the incidence of PONV, and assessing the severity of PONV.

MATERIALS AND METHODS

The present double-blind, randomised study was conducted at SRM Medical College and Hospital Research Centre, Chennai, Tamil Nadu, India for 18 months following approval from the Institutional Ethics Committee (SRMIEC-ST0723/540) and registration with the Clinical Trial Registry of India (CTRI/2023/12/060829). A total of 138 patients scheduled for elective lower limb surgeries were enrolled and allocated into three groups, with a sample size of 46 after obtaining written informed consent from each participant.

Inclusion criteria: Patients in the age group of 18 to 65 years with Body Mass Index (BMI) between 18.5 to 24.9, belonging to American Society of Anaesthesiologists (ASA) grades I and II, undergoing elective orthopaedic lower limb surgeries under spinal anaesthesia were included in this study.

Exclusion criteria: Patients with an allergy to study drugs, those requiring blood transfusion, those with QT prolongation, those with contraindications to spinal anaesthesia and patients refusing spinal anaesthesia were excluded from the study.

Sample size calculation: The sample size of 138 (46 in each group) was calculated based on a similar study by Ruku R et al., [9]. Based on this study [9], the incidence of postspinal shivering in ondansetron and palonosetron was assumed to be 40% and 15%, respectively. Taking the power of the test to be 90%, the sample size of 138 was calculated using a two-tailed null hypothesis.

The formula used for calculation was:

$n \geq (Z1\text{-}\alpha/2 + Z1\text{-}\beta)2\ (p1q1 + p2q2) / (p1\text{-}p2)2$ OR

$n = (p1-p2)2(Z1-\alpha/2+Z1-\beta)2\times(p1q1+p2q2)$

$Z1-\alpha/2$ = Z-score for the chosen significance level (α)=1.96

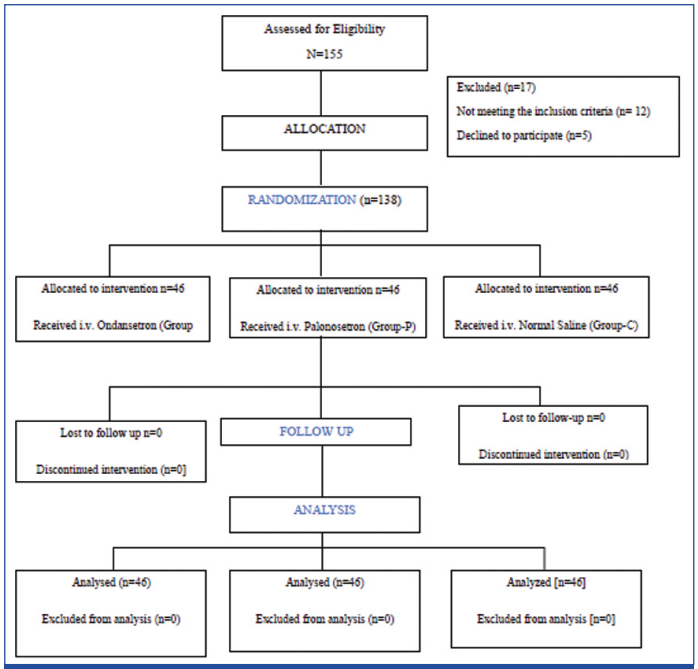
$Z1-\beta$ = Z-score for the chosen power (1 - β)=0.84

p1 = Proportion in group = 0.40, p2 = Proportion in group 2=0.15

q1 = 1–p1 = 1-0.40 = 0.60, q2 = 1–p2 = 1-0.15 =0.85

Study Procedure

All patients meeting the inclusion and exclusion criteria were evaluated in the preanaesthetic clinic. During this assessment, they were counselled on the anaesthetic technique, the need for postoperative analgesia, and the study methodology. Demographic details, such as age, sex, weight and height, were recorded. Patients were randomly assigned to three groups using a computer-generated random number table [Table/Fig-1]. Block randomisation was used to ensure balance between groups. To maintain allocation concealment, each patient received a unique number, which was written on a sheet of paper indicating their assigned group. This paper



[Table/Fig-1]: CONSORT flow chart.

was then placed inside a sealed, opaque envelope. The envelopes were opened sequentially just before each case. The randomisation process involved dividing participants into blocks of predefined sizes, with treatments assigned according to a predetermined random sequence generated electronically. Before each procedure, the first anaesthetist opened the envelope and prepared the treatment solution based on the assigned group. Meanwhile, the second anaesthetist, who conducted the procedure and recorded the data, remained blinded to the treatment assignment. This rigorous approach, using sealed opaque envelopes and role-specific blinding, ensured the integrity and validity of the study by minimising potential biases in treatment allocation and outcome assessment. Essential information, including age, weight, ASA grade, and surgical indication, was documented on a standardised form. The study participants were randomised into three groups, with all drugs administered 30 minutes before spinal anaesthesia. Group C received 5 mL of normal saline administered as a slow intravenous injection. Group O received 8 mg of intravenous ondansetron, diluted to 5 mL and given slowly. Group P received 0.075 mg of intravenous palonosetron, also diluted to 5 mL and administered as a slow injection. All participants received premedication with oral Alprazolam 0.25 mg and Ranitidine 150 mg the day before surgery. A Foley catheter was inserted to monitor urine output. In the operating theatre, patients were connected to a multiparameter monitor for continuous assessment of HR, respiratory rate, SpO2, NIBP, and a 3-lead ECG. An 18-G intravenous cannula was placed, and baseline measurements of vital signs were recorded. Spinal anaesthesia was administered using a 25-gauge Quincke needle at the L3-L4 or L4-L5 interspace, with 3 mL of 0.5% Bupivacaine and 20 mcg of Fentanyl injected after confirming free cerebrospinal fluid flow. Patients were then positioned supine with a pillow under their shoulders.

The operating theatre temperature was maintained between 18 to 22°C (±1°C). All patients received pre-warmed intravenous fluids and were covered with a Bair Hugger device set at 40°C. Body temperature was monitored using an infrared thermometer before surgery, immediately after spinal anaesthesia, every 10 minutes up to 30 minutes, every 30 minutes throughout surgery, and then hourly for 24 hours. HR and MAP were measured intraoperatively at 15, 45, 60, 90, and 120 minutes, and again at four hours. Shivering and episodes of nausea or vomiting were observed at the same intraoperative time intervals. PONV were similarly monitored at 15, 45, 60, 90, 120 minutes and four hours following surgery.

Shivering is defined as readily detectable fasciculations or tremors of the face, trunk or limbs of a minimum of 15 seconds duration [9]. The incidence of shivering will be noted when the shivering grade is more than 1, and the intensity is graded based on the grading described by Wrench IJ et al., [10]. Shivering was assessed and classified into five grades based on severity. Grade 0 indicated no shivering. Grade 1 was characterised by one or more of the following signs, such as peripheral vasoconstriction, piloerection, or peripheral cyanosis without any other identifiable cause, but without visible muscle activity. Grade 2 involved visible muscle activity confined to a single muscle group. Grade 3 was defined by visible muscle activity involving more than one muscle group. If the patient develops shivering with the intensity of Grade 2 or above, it was noted. The time of shivering onset was recorded. Patients experiencing shivering of Grade 1 or 2 were managed with standard treatment, including oxygen administration and a warming blanket.

For those who develop Grade 3 or 4 shivering persisting for more than 15 minutes, prophylaxis would be considered ineffective, and a rescue dose of Inj. tramadol 50 mg i.v. bolus will be administered, and the number of doses of tramadol will be noted. None of the participants in the study developed Grade 3 or 4 shivering. The incidence of nausea and vomiting was noted. Any episode of bradycardia and hypotension was noted, and at the end of the surgery, the patient was shifted to the PACU.

Postoperative nausea and vomiting were observed at the above time frames, depending on the Bellville severity score of PONV. The Bellville Scoring System is a semi-quantitative tool used to assess the severity of PONV based on the presence and frequency of nausea and vomiting episodes during the postoperative period using a 5-point scoring system [11]. Score 0 indicated no nausea or vomiting. Score 1 represented mild nausea without any episodes of vomiting. Score 2 corresponded to moderate nausea accompanied by one to two episodes of vomiting. Score 3 was assigned to patients experiencing severe nausea with three or more episodes of vomiting. Score 4 denoted intractable vomiting that required medical intervention [11].

STATISTICAL ANALYSIS

Results were presented with a 95% confidence interval, and a p-value of less than 0.05 was considered statistically significant. The data was entered into Microsoft Excel and analysed using the statistical software SPSS (Statistical Package for the Social Sciences) version 20.0. Descriptive statistics, including measures such as mean, standard deviation, median, and interquartile range, were used to summarise quantitative variables. To compare the effects, a One-way ANOVA test was conducted, while the Chi-square test was employed for comparing quantitative data. Fisher's-exact test was applied to compare categorical values such as the presence or absence of PONV across different groups, ensuring accurate statistical interpretation even with limited data points.

RESULTS

A total of 138 patients were randomly assigned to three groups, each consisting of 46 participants. Demographic details such as age, gender, weight, height, BMI, blood pressure, HR, SpO_2 and ASA grading did not show any statistical difference, as shown in [Table/Fig-2] below.

Parameter	Group C (n=46)	Group O (n=46)	Group P (n=46)	p-value
Age (years)	39.46±14.24	40.43±11.65	40.24±14.76	0.251#
Gender (M/F)	Male: 32 (69.57%) Female: 14 (30.43%)	Male: 30 (65.22%) Female: 16 (34.78%)	Male: 34 (73.91%) Female: 12 (26.09%)	0.663#
Weight (kg)	65.89±8.55	65.59±7.36	67.02±6.63	0.228#
Height (cm)	168.62±10.07	167.98±8.88	169.63±7.08	0.902#
BMI (kg/m²)	23.18±1.22	23.23±0.93	23.21±0.88	0.96#
Systolic BP (mmHg)	120±8.23	119.17±7.49	117.57±5.77	0.059#
Diastolic BP (mmHg)	78.89±3.55	78.61±4.18	77.48±4.54	0.256#
Heart Rate (HR) (bpm)	80.39±3.64	79.93±3.99	80±3.28	0.426#
SpO_2 (%)	99.09±0.89	98.76±0.79	98.67±0.82	0.728#
ASA Grade	1.54±0.50	1.46±0.50	1.52±0.51	0.721#

[Table/Fig-2]: Baseline demographic and clinical characteristics across groups.
Data expressed as Mean±SD for continuous variables and frequency (percentage) for categorical variables. # p-value not significant. A One-way ANOVA test was used to compare all continuous variables, while the Chi-square test was applied for the comparison of gender between the groups.

Intraoperative Assessment of HR and MAP at different time intervals, as shown in [Table/Fig-3], was not statistically significant.

Grade 2 shivering during the intraoperative period: [Table/Fig-4] presents the incidence of Grade 2 shivering during the intraoperative period across the three study groups. Grade 2 shivering was observed at 15 minutes, with the highest incidence in group C (43.48%) and the lowest in group P (6.52%), showing a highly significant difference (p<0.0001). At 45 minutes, shivering persisted in Groups C and O (23.91% each) but remained low in group P (6.52%), with a significant difference (p=0.044). By 60 minutes, shivering incidence dropped across all groups, with no significant difference (p=0.165), and further declined at 90 minutes and beyond. No Grade 2 shivering was observed at 120 minutes or four hours in any group. Overall, group P consistently showed the least shivering, especially in the early postoperative period. Grade 3 or Grade 4 shivering was not observed in the three groups.

Nausea during the intraoperative period: The data in [Table/Fig-5] present the incidence of nausea during the intraoperative period across the three study groups. Nausea was most frequent in group C, particularly at 45 minutes (13.04%) and 60 minutes (10.87%), showing significant differences compared to other groups (p=0.009 and p=0.026, respectively). Group P (palonosetron) had no cases of nausea until four hours postoperatively, indicating the lowest incidence overall. Group O (ondansetron) had fewer cases than the control, but was less effective than palonosetron. From 90 minutes onwards, nausea incidence declined across all groups. palonosetron was the most effective in preventing intraoperative and early postoperative nausea. Vomiting during the intraoperative period did not show any statistical significance.

Time	HR (Group C)	HR (Group O)	HR (Group P)	HR p-value	MAP (Group C)	MAP (Group O)	MAP (Group P)	MAP p-value
15 min	80.35±3.88	80.37±3.95	80.78±3.88	0.89#	79.76±4.08	79.80±3.35	80.11±3.82	0.87#
45 min	76.69±7.13	76.57±7.11	77.17±3.72	0.95#	76.85±3.99	77.33±3.51	78.85±3.07	0.12#
60 min	76.76±4.40	76.89±4.10	77.26±4.57	0.88#	76.54±5.06	76.54±5.03	77.69±3.07	0.63#
90 min	77.98±3.14	79.22±2.93	78.48±3.13	0.34#	78.11±3.06	78.11±2.75	78.17±2.98	0.99#
120 min	78.78±3.03	79.09±2.43	80.30±2.71	0.08#	78.85±3.25	78.54±2.68	78.11±3.09	0.63#
4 h	80.02±3.04	79.72±2.48	79.48±2.81	0.83#	79.04±5.8	79.46±2.23	77.30±12.88	0.71#

[Table/Fig-3]: Intraoperative Assessment of Heart Rate (HR) and Mean Arterial Pressure (MAP).
Data expressed as Mean±SD. # p-value not significant. A One-way ANOVA test was used to compare all continuous variables

Time	Grade 2 shivering			p-value
	Group C	Group O	Group P	
15 min	20 (43.48%)	7 (15.22%)	3 (6.52%)	<0.0001*
45 min	11 (23.91%)	11 (23.91%)	3 (6.52%)	0.044*
60 min	3 (6.52%)	1 (2.17%)	0 (0%)	0.165#
90 min	1 (2.17%)	0 (0%)	0 (0%)	0.365#
120 min	0 (0%)	0 (0%)	0 (0%)	-
4 h	0 (0%)	0 (0%)	0 (0%)	-

[Table/Fig-4]: Grade 2 shivering during the intraoperative period.
Data expressed as frequency and percentage. # p-value not significant, *p-value significant. The Chi-square test and Fisher's-exact Test were used to compare the incidence of Grade 2 shivering between the groups at each intraoperative time point.

Time	Nausea			p-value
	Group C	Group O	Group P	
15 min	3 (6.52%)	3 (6.52%)	0 (0%)	0.208#
45 min	6 (13.04%)	1 (2.17%)	0 (0%)	0.009*
60 min	5 (10.87%)	1 (2.17%)	0 (0%)	0.026*
90 min	0 (0%)	1 (2.17%)	0 (0%)	0.365#
120 min	0 (0%)	0 (0%)	0 (0%)	-
4 h	0 (0%)	0 (0%)	1 (2.17%)	0.365#

[Table/Fig-5]: Nausea during the intraoperative period.
Data are expressed as frequency and percentage. #p-value not significant, *p-value significant. The incidence of nausea during the intraoperative period was compared between the three groups at each time interval using either the Chi-square test or Fisher's-Exact Test, as appropriate. The Chi-square test was applied when the expected cell frequencies were adequate, while Fisher's-Exact Test was used in instances where expected frequencies were less than 5. A p-value of <0.05 was considered statistically significant.

Intergroup comparison of intraoperative grade 2 shivering: As shown in [Table/Fig-6], there was a statistically significant difference between group C and group O at 15 minutes (p=0.0031) and between group P and group C (p<0.0001). The difference between group P and group O was not significant (p=0.1825). For 45 minutes, a highly significant difference was noted between group O and group P (p=0.0209) as well as between group P and group C (p=0.0209). For 60 minutes, no statistically significant differences were noted between any of the groups. At 90 minutes, a non-significant difference was observed between group C and group P (p=0.3178). These findings suggest that palonosetron had a more sustained and significant effect in reducing Grade 2 shivering compared to ondansetron and control.

Time	Grade 2 shivering		
	Group C vs Group O	Group O vs Group P	Group P vs Group C
15 min	0.0031*	0.1825#	< 0.0001*
45 min	1.0000#	0.0209*	0.0209*
60 min	0.3088#	0.4989#	0.0799#
90 min	0.3178#	-	0.3178#
120 min	-	-	-
4 h	-	-	-

[Table/Fig-6]: Intergroup comparison of Intraoperative Grade 2 shivering # p-value not significant, *p-value significant. For the intergroup comparison of intraoperative Grade 2 shivering, Fisher's-Exact Test was applied to compare proportions between pairs of groups (group C vs O, group O vs P, and group P vs C) at each time point. A p-value of <0.05 was considered statistically significant.

Intergroup comparison of intraoperative nausea: At 15 minutes, there were no significant differences between the groups in nausea incidence, with p-values 1.0000 for group C compared with group O and 0.0799 for both group O compared with group P and group P compared with group C.

At 45 minutes, there was a borderline significance between group C and group O (p=0.0505), and a statistically significant difference between group P and group C (p=0.0118). There was no significant difference between group O and group P (p=0.3178).

By 60 minutes, group P and group C were still statistically significant (p=0.0222), whereas group O vs. group P and group C vs. group O comparisons were still non-significant (p=0.3178 and 0.0928). No statistical differences were seen between any of the groups at 90 minutes (p=0.3178) and by four hours, differences between group O vs. group P and group P vs. group C were non-significant (p=0.3178). The findings, as indicated in [Table/Fig-7], show that palonosetron had superior efficacy in suppressing intraoperative nausea in the initial postoperative time, particularly from 45 to 60 minutes.

Time Interval (minutes)	Parameter	Group C vs Group O	Group O vs Group P	Group P vs Group C
15	Grade 2 shivering	0.0031*	0.1825#	<0.0001*
	Nausea	1.0000#	0.0799#	0.0799#
45	Grade 2 shivering	1.0000#	0.0209*	0.0209*
	Nausea	0.0505#	0.3178#	0.0118*
60	Grade 2 shivering	0.3088#	0.4989#	0.0799#
	Nausea	0.0928#	0.3178#	0.0222*
90	Grade 2 shivering	0.3178#	–	0.3178#
	Nausea	0.3178#	0.3178#	–
120	Grade 2 shivering	–	–	–
	Nausea	–	–	–
4 hours	Grade 2 shivering	–	–	–
	Nausea	–	0.3178#	0.3178#

[Table/Fig-7]: Intergroup comparison of intraoperative Grade 2 shivering and nausea.
*Statistically significant p-value (p<0.05) # Not statistically significant (p≥0.05)
– Data not available/applicable. For the intergroup comparison of intraoperative Grade 2 shivering and nausea, Fisher's-Exact Test was employed to compare categorical outcomes between pairs of groups at each time interval.

Postoperative assessment: PONV was most common in the control group (23.91%), followed by group O (ondansetron, 10.87%) and least in group P (palonosetron, 6.52%). The majority of patients in all groups remained symptom-free, with the highest proportion in group P (93.48%). The difference was statistically significant (p=0.048), showing both antiemetics were effective, with palonosetron being the most effective in reducing PONV, as shown in [Table/Fig-8].

Postoperative Nausea and Vomiting (PONV)	Group C	Group O	Group P	p-value
Yes	11 (23.91%)	5 (10.87%)	3 (6.52%)	0.0480*
No	36 (76.09%)	41 (89.13%)	43 (93.48%)	

[Table/Fig-8]: Nausea during the postoperative period.
Data are expressed as frequency and percentage, *p-value significant. The comparison of PONV among the three groups was performed using the Chi-square test of independence. A p-value of <0.05 was considered statistically significant

Bellville score: Bellville score distribution between the three groups indicated a statistically significant difference (p=0.009) over 24 hours, as shown in [Table/Fig-9]. More participants in group P (93.5%) and group O (89.1%) scored 0.00 on the Bellville Score. Fewer participants in group C scored 0.00 at 76.1%. Furthermore, 13% of group C respondents showed an increased Bellville Score of 2.00, and no scores of this type were found among either group O or group P.

Bellville score	Group C	Group O	Group P	Individual p-values	p-value
0.00	35 (76.1%)	41 (89.1%)	43 (93.5%)	0.0418*	0.009*
1.00	5 (10.9%)	5 (10.9%)	3 (6.5%)	0.7120 #	
2.00	6 (13.0%)	0 (0.0%)	0 (0.0%)	0.0019 *	

[Table/Fig-9]: Bellville Score Data expressed as frequency and percentage, *p-value significant Bellville scores were compared among the three groups using the Chi-square test of independence. A p-value of <0.05 was considered statistically significant.# Statistically not significant (p≥0.05)

Intergroup comparison of PONV and Bellville score: [Table/Fig-10] shows the intergroup comparison of PONV showed a

statistically significant difference between group C and group P, with the p-value being 0.0209, and it was therefore shown that palonosetron was better than the control in the prevention of PONV. Comparisons between group C (Control) and group O, as well as between group O and group P, were not statistically significant, with p-values being 0.1008 and 0.4615, respectively. Intergroup comparison of the Bellville Score revealed a substantial difference between group P and group C, especially for scores of 0.00 and 2.00. A much larger proportion of patients in group P had a score of 0.00 than in group C (p=0.0208). In contrast, a Bellville Score of 2.00 was found only in Group C, and this was statistically significant compared with both group O and group P (p=0.0119). There were no significant differences between group O and group P for any of the score levels. These results indicate that patients treated with palonosetron (group P) felt the maximum level of assurance and confidence, followed by the patients treated with ondansetron (group O), with the reassurance being minimal in the control group (group C).

Parameters	Group C vs Group O	Group O vs Group P	Group P vs Group C
PONV	0.1008#	0.4615#	0.0209*
Bellville score 0.00	0.1019#	0.4565#	0.0208*
Bellville score 1.00	1.000#	0.4565#	0.4565#
Bellville score 2.00	0.0119*	–	0.0119*

[Table/Fig-10]: Intergroup comparison of postoperative nausea and Bellville Score.
*Statistically significant p-value (p<0.05) # Not statistically significant (p≥0.05), -Data not applicable. Intergroup comparisons of PONV and Bellville scores were performed using Fisher's-Exact Test. A p-value<0.05 was considered statistically significant.

DISCUSSION

Haemodynamic parameters during intraoperative period: The HRs at all intervals was similar in all groups, with no significant differences between them. On comparing MAP, a notable difference at time intervals; MAP values remained comparable across all groups, with no significant differences detected. Kim MK et al., while comparing intravenous palonosetron and ondansetron to prevent hypotension caused by spinal anaesthesia during caesarean sections in women, did not find any haemodynamic parameters like HR and MAP varying significantly between the two groups [12].

Intraoperative grade 2 shivering: In this study, palonosetron (group P) significantly reduced intraoperative Grade 2 shivering compared to ondansetron (group O) and the control group (group C). At 15 minutes, shivering occurred in 43.48% of group C, 15.22% of group O, and only 6.52% of group P (p<0.0001). This trend continued at 45 minutes, with 23.91% in group C and O, and 6.52% in group P (p=0.044). By 60 minutes, shivering declined across all groups with no significant differences. Sharma et al., in a randomised double-blind study involving patients undergoing elective lower segment caesarean section (LSCS) under spinal anaesthesia, observed that palonosetron reduced the incidence of shivering from 23.8% to 9.5%. Their study further confirmed that palonosetron was significantly more effective than ondansetron in the prevention of post-anaesthetic shivering [13]. Zhang Y et al., in their research, discovered that ondansetron on intraoperative shivering during caesarean section under spinal anaesthesia demonstrates a considerably lower incidence of shivering in the ondansetron group (2.5%) than in the control group (22.3%), which suggests that ondansetron is effective in reducing shivering [14].

Intraoperative nausea and vomiting: The present study's results suggest that palonosetron is more effective in preventing intraoperative nausea compared to ondansetron and the Control group, with statistically significant data. All groups had low intraoperative vomiting rates, with no statistically significant differences at any time. Palonosetron was reported to be more effective than ondansetron by Liu Q et al., in preventing vomiting following laparoscopic surgery [15]. A comprehensive study and meta-analysis by Kumar J et al. found that palonosetron is more effective than ondansetron in the first 24 hours postoperatively and needs less rescue antiemetic [16].

Postoperative assessment: In this study, the difference between the incidence of PONV between the groups was significant (p=0.048), suggesting that both ondansetron and palonosetron were effective in minimising postoperative nausea and vomiting, with palonosetron showing better efficacy. In the 2-24-hour postoperative interval, Balyan R et al., found that palonosetron minimises the need for rescue antiemetics, reduces total PONV, and is more effective than ondansetron [17]. According to research by Campos GO et al., palonosetron was shown to be as effective as ondansetron in lowering the overall incidence of PONV [18]. Bhargava T et al., noted that palonosetron prevents early and delayed PONV better than ondansetron in live-related kidney transplant patients [19]. Palonosetron provides better preventive effects than ondansetron in both acute and delayed CINV, according to research that focused on chemotherapy-induced nausea and vomiting. This finding may have significance for the treatment of PONV [19].Clinical Implications and Recommendations: In individuals who are susceptible to PONV and postspinal shivering, palonosetron may be a first-line treatment due to its exceptional effectiveness in avoiding these side-effects. The prolonged half-life of palonosetron reduces the need for repeat dosing, which is advantageous in procedures requiring extended postoperative monitoring [20]. Haemodynamic stability, oxygen usage, and overall patient comfort can all be greatly improved by lowering the frequency and severity of shivering during the perioperative phase [21]. In addition to lowering these risks, effective shivering treatment improves patient comfort and makes the recovery from surgery more positive [22].

Limitation(s)

This single-centre study may limit the generalisability of the results to other settings. Only immediate postoperative outcomes were assessed, and long-term effects of palonosetron and ondansetron on shivering and PONV were not evaluated. A larger sample size may enhance the reliability and statistical significance of the findings.

CONCLUSION(S)

The results of this study demonstrated that palonosetron is more effective than ondansetron in reducing postspinal anaesthesia shivering. Patients who were administered palonosetron exhibited a significantly lower incidence and severity of shivering compared to those receiving ondansetron. Furthermore, palonosetron was associated with a lower incidence of intraoperative and PONV. The superior efficacy of palonosetron may be attributed to its longer half-life and higher receptor binding affinity. These pharmacological properties contribute to prolonged anti-shivering and antiemetic effects. Based on these findings, palonosetron may be considered a more effective prophylactic option for the prevention of postspinal shivering and better control of PONV in clinical practice.

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