Comparison of Low-Dose Ketamine and Propofol Effects on Preventing Shivering in Cesarean Section under Spinal Anesthesia

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Abstract: Post-operative shivering is a common problem after anesthesia and can cause many complications, such as increased oxygen consumption, increased carbon dioxide production, and hyperalgesia at the surgical site. In the present study, the effect of a low dose of Ketamine and Propofol on the prevention of shivering in patients undergoing cesarean section by spinal anesthesia, with low risk and safe drugs, was investigated. In this randomized, triple-blind study, 147 patients undergoing elective cesarean section by spinal anesthesia with ASA I and II, in the age range of 15-45 years, were divided into three groups with 49 candidates in each one. Ketamine and Propofol 0.3 mg/kg and 2 cc of normal saline were respectfully injected into the first, second, and third groups after childbirth. The patients were evaluated during the surgery and up to half an hour after the surgery in the recovery room. The observations were recorded in the relevant questionnaires for shivering, nausea, and vomiting. There were no significant differences among the three groups regarding age, weight, gestational age, history of previous surgery, and ASA ($p > 0.05$). There was a significant difference between the placebo and ketamine groups ($p = 0.004$) and the Propofol group ($p = 0.032$) during the surgery. Half an hour after the surgery, shivering was significantly different between the placebo and ketamine groups ($p = 0.041$) and the Propofol group ($p < 0.0001$). There was no significant difference in the incidence of nausea and vomiting during the surgery ($p = 0.318$). However, half an hour after the surgery in the recovery room, there was a significant difference in the placebo group compared to the ketamine and Propofol group ($p = 0.006$). The present study showed that ketamine and Propofol effectively prevent shivering and post-operative nausea and vomiting. Therefore, in the case of prohibition of other drugs, ketamine and Propofol effectively prevent postanesthetic shivering, nausea, and vomiting. Given the side effects of opioids, these drugs can be a good alternative for them.

Keywords: post-operative shivering, ketamine, Propofol, Cesarean section, spinal anesthesia.

小剂量氯胺酮与丙泊酚预防脊髓麻醉剖宫产颤抖效果的比较

摘要: 术后颤抖是麻醉后的常见问题，可引起许多并发症，例如耗氧量增加、二氧化碳产生增加和手术部位痛觉过敏。在本研究中，研究了低剂量氯胺酮和丙泊酚对预防腰麻剖宫产患者颤抖的效果，使用低风险和安全的药物。在这项随机、三盲研究中，147 名年龄在 15-45 岁之间的作为一个 I 和 II 型脊髓麻醉择期剖宫产患者被分为三组，每组 49 名候选人。产后第一、二、三组分别注射氯胺酮、丙泊酚 0.3 毫克/公斤和生理盐水 2 抄送。患者在手术期间和手术后半小时内在恢复室接受评估。观察结果记录在有关颤抖、恶心和呕吐的问卷中。三组之间在年龄、体重、胎龄、既往手术史和作为一个方面无显着差异（$p > 0.05$）。在手术期间，安慰剂和氯胺酮组（$p = 0.004$）和丙泊酚组（$p = 0.032$）之间存在显着差异。手术后半小时，安慰剂组和氯胺酮组（$p = 0.041$）和丙泊酚组（$p < 0.0001$）之间的颤抖有显着差异。手术期间恶心和呕吐的发生率没有显着差异（$p = 0.318$）。然而，在恢复室手术后半

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小时，安慰剂组与氯胺酮和丙泊酚组相比存在显着差异（p = 0.006）。目前的研究表明，氯胺酮和丙泊酚可有效防止颤抖和术后恶心呕吐。因此，在禁用其他药物的情况下，氯胺酮和丙泊酚可有效防止麻醉后的寒战、恶心、呕吐。鉴于阿片类药物的副作用，这些药物可能是他们的一个很好的替代品。

关键词： 术后寒战、氯胺酮、丙泊酚、剖宫产、腰麻。

1. Introduction

The central body temperature is one of the most important and stable variables in maintaining the physiology of the human body. Abnormalities such as hypothermia during surgery can lead to problems, such as postoperative shivering, coagulation disorders, impaired body nitrogen balance, and changes in pharmacokinetics [1]. Moreover, postoperative shivering can cause various side effects: increased oxygen consumption, increased carbon dioxide production, increased heart rate. Consequently, it can also lead to an exacerbated ischemic heart disease, as well as increased intracranial pressure, increased intraocular pressure, hyperalgia in surgical site along with discomfort. Most anesthetic agents cause peripheral vasodilatation and inhibit responses of the central temperature regulation during the administration of anesthesia, such as vasoconstrictive thresholds [2]. The reasons for post anesthetic shivering are divided into two types: temperature regulation-dependent and temperature regulation-nondependent. The temperature regulation system-dependent type is caused by the loss of patient's body temperature in the operating room through radiation, convection, contact, sweating, and cold fluids. The independent type of body temperature regulation system is caused by the effect of anesthetic drugs or postoperative pain [3].

Nowadays, various pharmacological and non-pharmacological solutions have been devised to prevent hypothermia and shivering. Keeping the patient warm before and during the operation and preventing the cooling of the operating room are the most important non-pharmacological methods that are mentioned [2]. Various drugs have been suggested for the prevention and treatment of postoperative shivering, including Meperidine, Ketanserin, Alfentatil, Sufentanil, Tramadol, Physostigmine, and Clonidine [3]. Each of these has its own side effects [4, 5, 6, 7]. However, Meperidine is the most effective treatment among them. Although the mechanism of action of Meperidine is not fully understood, it is likely to act directly on the body's temperature regulation center or through opioid receptors. It is also likely that N-methyl-D-aspartate receptor antagonists modulate the temperature regulation system at different levels. Ketamine, a competitive antagonist of N-methyl-D-aspartate, has been reported as a post-operative shivering inhibitor [3]. The incidence of post-operative shivering is 5-60% and varies according to the age and gender of patients, anesthesia techniques, and duration of surgery [8]. The incidence of shivering after spinal anesthesia is 36-85% [9].

Lema et al. [10] investigated the efficacy of intravenous tramadol and low-dose ketamine in preventing post-spinal anesthesia shivering with cesarean section. Their study showed that the prophylactic injection of low-dose IV ketamine or IV tramadol effectively reduces the incidence and intensity of shivering. Kheirandish et al. [11] evaluated the impact of using isoflurane and Propofol on shivering among patients undergoing vitrectomy surgery. Their study showed that using isoflurane is better than Propofol for reducing post-operative shivering in patients undergoing vitrectomy surgery.

Nausea and vomiting commonly occur in patients undergoing cesarean section with spinal anesthesia when no prophylactic anti-emetic medication is used, causing unpleasant sensations in the patient [2, 12]. Intra Operative Nausea and Vomiting is distressing for patients, obstetricians, anesthetists; and may increase the risk of visceral injury during surgery by involuntary uncontrolled abdominal movements [13, 14]. Given the importance of controlling post-operative shivering, this study aimed to compare the prophylactic effect of ketamine and Propofol on post-operative shivering rate in the cesarean section under spinal anesthesia to have a suitable alternative for opioids, considering their side effects.

We conducted a research study with these hypotheses.

1. Does ketamine affect the prevention of chills?
2. Is Propofol effective in preventing chills?
3. Is ketamine effective in preventing nausea and vomiting?
4. Is Propofol effective in preventing nausea and vomiting?

2. Material and Methods

This study was a triple-blind, randomized clinical trial performed in Alavi Hospital in Ardebil, Iran, during the years 1397-1398. The study population

consisted of all pregnant women who, due to indications for elective cesarean section, were candidates for this surgery at Alavi Hospital of Ardabil. The sample size was calculated based on similar studies [13] and reducing about 30% of shivering rate when using both drugs, with an alpha level equal to 5% and the study power equal to 80% power and P1 = 40% in the Propofol group and P2 = 60% in the ketamine group. There were 49 samples in each group (totally, 147 samples). The operating room temperature was 22-23°C, and crystalloid was kept at operating room temperature used. For preventing hypothermia, the fabric was placed underneath all patients.

This study involved 147 ASA I and II patients aged 15-45. Convenience sampling was used to involve the patients in this study, and they were randomly divided into ketamine, Propofol, and placebo groups. Random allocation of this study was the envelope randomization method, designed to randomize 147 envelopes, including 49 Type-A envelopes, 49 Type-B envelopes, and 49 Type-C envelopes. One envelope was selected from 147 available envelopes for the drug injection into the patient. The drug was injected into each patient according to the envelope type (A, B, or C). The drug preparation was performed by an anesthetic technician who did not play a role in this study. These three drugs were injected intravenously by the anesthesiology resident immediately after the childbirth, according to the grouping of the patients. The ketamine group received 0.3 mg/kg of ketamine, the Propofol group received 0.3 mg/kg of Propofol, and the placebo group received 2 cc of normal saline. The volume of injectable solution was equal in all three groups. Patients were unaware of the type of the received drug (first type blinding).

Patients with the following criteria were excluded from the study: history of allergy to Ketamine or Propofol, placenta Previa, preeclampsia, Reynold's syndrome, hypothyroidism and hyperthyroidism, cardiovascular disease, mental health disorders, initial body temperature <38 or> 36, and those who had significant bleeding during surgery, general anesthesia following a failed spinal anesthesia.

The method was explained to the patients before their entrance to the operating room. Prior to surgery, written consent was obtained from all patients. The physician and executor of the plan kept patients' personal information confidential, and no patient's name was mentioned in the study. The study had no financial burden on patients. The research has been approved by the University Ethics Committee ARUMS.REC.1396.203 code and has also been registered at the Iranian Registry with IRCT20180930041181N1 code of Clinical Trial.

In this study, all patients underwent spinal anesthesia by 0.5% Marcaine. Spinal anesthesia was performed for all patients sitting from L3-L4 or L4-L5 interspace with 25 gauge Quincke needles. During surgery, patients had cardiac monitoring and oxygen mask. Hemodynamic signs of patients, including blood pressure, heart rate, respiratory rate, and arterial oxygen saturation, were monitored by an anesthetic technician.

Cases with shivering during the surgery and up to half an hour after the operation in the recovery room were recorded according to the grading scale for shivering by trained interns who were not aware of the type of the injected drug (type II blinding). Grading was as follows: Grade 0: No shivering observed;

Grade 1: One or more piloerections; peripheral cyanosis without other causes, but without visible muscular activity;

Grade 2: Visible muscle activity confined to one muscle group;

Grade 3: Visible muscle activity in more than one muscle group;

Grade 4: Gross muscular activity involving the entire body.

The patients were asked about nausea and vomiting by the intern during and in half an hour after the surgery and recorded according to nausea and vomiting grading scale. Grading was as follow:

Grade 1: No nausea;

Grade 2: Only nausea;

Grade 3: Nausea with up to two episodes of vomiting;

Grade 4: Nausea with more than two episodes of vomiting.

In this study, patients with Grade 3 and 4 shiverings were treated intravenously with 25 mg of meperidine. Patients with Grade 3 and 4 nausea and vomiting received a slow injection of 0.5 mg of atropine and, if necessary, 10 mg of Metoclopramide intravenously. The results were recorded. Patients with hypotension were treated with injections of Ephedrine or Atropine.

The questionnaires' information was entered into the SPSSv23 program and analyzed using Chi-Square and ANOVA tests. P-values less than 0.05 were considered significant.

3. Results

In the present study, patients' demographic data, including age, weight, ASA, gestational age, and history of previous surgery, were recorded in Table 1.

Table 1 Patients' demographic information

		Ketamine group	**Propofol group**	**Placebo group**
Age	Mean age	27.76	29.96	27.63
	Standard deviation	6.647	6.045	5.865
	P-Value	0.116		
Weight	Average weight	75.69	77.24	74.65

	Standard deviation	9.954	11.640	9.264
	P-Value	0.460		
ASA	ASA I	81.6	73.5	79.6
	ASA II	18.4	26.5	20.4
	P-Value	0.595		
Gestational age	mean	38Ws,1D	37Ws,6Ds	38Ws
	Standard deviation	2Ws,5Ds	1W,4Ds	2Ws,2Ds
	P-Value	0.784		
History of previous surgery	positive	55.1	61.2	53.1
	P-value	0.698		

ANOVA test showed that there were no significant differences among the three groups regarding mean age (P = 0.116), mean weight (P = 0.460), ASA (P = 0.595), gestational age (P = 0.784) and history of previous surgery (p = 0.698). Patients' shivering was evaluated during surgery and half an hour after surgery in the recovery room.

The data showed that the highest and lowest incidence of shivering during surgery were respectively in the placebo and ketamine groups. Regarding the shivering, the differences between the two groups were considered significant (P-value = 0.004). There was no significant difference between the ketamine and Propofol groups (P-value = 0/6106). However, there were significant differences between the ketamine and placebo groups (P-value = 0.004) and the Propofol and placebo groups (P-value = 0.032) (Table 2).

Table 2 Frequency of shivering in different groups at different time points

Shivering	**During surgery**			**Half an hour after surgery in the recovery room**		
	Ketamine group	**Propofol group**	**Placebo group**	**Ketamine group**	**Propofol group**	**Placebo group**
No shivering	(83.7%)41	(77.6%)38	(55.1%)27	(81.6%)40	(67.3%)33	(44.9%)22
shivering	(16.3%)8	(22.4%)11	(44.9%)22	(18.4%)9	(32.7%)16	(55.1%)27
P-value	0.004			0.001		

Post-operative shivering was observed in the recovery room, with the highest incidence of shivering in the placebo group and the lowest in the ketamine group. Regarding the shivering half an hour after surgery, the difference between the two groups was significant (p-value = 0.001). There was no significant difference between the ketamine and Propofol groups (P-value = 0.167). There were significant differences between the ketamine and placebo groups (P-value < 0.0001) and the Propofol and placebo groups (P-value = 0.041). Shivering intensity in groups during surgery and half an hour after surgery in the recovery room was evaluated based on the shivering grading scale (Table 3).

Table 3 Shivering intensity in groups at different time points

Shivering intensity	**During surgery**			**Half an hour after surgery in the recovery room**		
	Ketamine	**Propofol**	**Placebo**	**Ketamine**	**Propofol**	**Placebo**
0	(83.7%)41	(77.6%)38	(55.1%)27	(81.6%)40	(67.3%)33	(44.9%)22
1	(4.1%)2	(10.2%)5	(12.2%)6	(0%)0	(18.4%)9	(14.3%)7
2	(8.2%)4	(6.1%)3	(14.3%)7	(14.3%)7	(8.2%)4	(20.4%)10
3	(4.1%)2	(2%)1	(10.2%)5	(4.1%)2	(0%)0	(12.2%)6
4	(0%)0	(4.1%)2	(8.2%)4	(0%)0	(6.1%)3	(8.2%)4
P-value	0.077			0.001		

In our study, the highest Grade 1, 2, 3, and 4 shivering rates occurred in the placebo group. The lowest Grade 1 and 4 shivering rates occurred in the ketamine group. The lowest Grade 2 and 3 shivering rates occurred in the Propofol group. According to the p-value = 0.077, the difference between the groups during the surgery was not statistically significant in terms of grading.

Half an hour after surgery, the highest rates of Grade 2, 3, and 4 shivering were in the placebo group and Grade 1 shivering in the Propofol group. The lowest rates of Grade 1 and 4 shivering were in the ketamine group and Grade 2 and 3 in the Propofol group. According to P-value = 0.001, there was a significant difference between groups regarding the shivering in the recovery room half an hour after surgery. Comparing the ketamine group with the Propofol group (p-value = 0.004) and the ketamine group with the placebo group (p-value = 0.001) and the Propofol group with the placebo group (p-value = 0.025) indicates that the differences were statistically significant regarding the shivering in the recovery room half an hour after surgery.

In this study, patients with shivering of grade 3 or higher were treated with 25 mg meperidine. Of the 49 patients in the ketamine group, 1 (2%) was treated with meperidine intraoperatively, and 2 (4.1%) received post-operative meperidine. In the propofol group, 1

patient (2%) was treated with meperidine intraoperatively and 5 (6.1%) were treated with meperidine postoperatively. Lastly, in the placebo group, 1 patient (2%) was treated with meperidine intraoperatively, and 10 (20.4%) were treated with meperidine postoperatively. There was no significant difference among the groups regarding meperidine injections ($p = 0.075$). It should be noted that the patients were treated with meperidine only once (either intraoperatively or postoperatively).

The frequency of nausea and vomiting in the treatment groups during surgery and half an hour after surgery in the recovery room was evaluated using the nausea and vomiting score and statistically assessed using chi-squared tests. In this study, nausea and vomiting were seen in 14.3%, 26.5%, and 26.5% of patients in the ketamine, propofol, and placebo groups, respectively, during surgery. At 30 minutes postoperatively in the recovery room, nausea and vomiting were not seen in the ketamine and propofol groups and affected 8 patients of the placebo group (Table 4).

Table 4 Frequency of nausea and vomiting in different groups at different intervals

Nausea and vomiting	**During surgery**			**Half an hour after surgery**		
	Ketamine	**Propofol**	**Placebo**	**Ketamine**	**Propofol**	**Placebo**
Absent	(85.7%)42	(73.5%)36	(77.6%)38	(100%)49	(100%)49	(83.7%)41
Present	(14.3%)7	(26.5%)13	(22.4%)11	(0%)0	(0%)0	(16.3%)8
P-value	0.318			$P < 0.0001$		

According to the data, the highest incidence of intraoperative nausea and vomiting was in the propofol group, while the lowest incidence was in the ketamine group. The incidence of nausea and vomiting during surgery was not significantly different between groups ($p = 0.318$).

There was a statistically significant difference in the incidence of nausea and vomiting among the groups half an hour after surgery ($p < 0.0001$). Specifically, the ketamine and propofol groups had significantly lower rates of nausea and vomiting than the placebo group ($p = 0.006$).

In terms of the severity of intraoperative nausea and vomiting, the highest incidence of grade 2 events was in the propofol group, grade 3 events in the placebo group, and grade 4 events in the ketamine group, while the lowest incidence of grade 2 and 3 events were in the ketamine group and grade 4 events in the propofol and placebo groups. There was no significant difference among the groups in the severity of nausea and vomiting during the operation ($p = 0.169$).

With regard to postoperative nausea and vomiting, the highest incidence of grade 2 and 3 events was in the placebo group, and the lowest incidence of grade 2 and 3 events was in both the ketamine and propofol groups. The incidence of grade 4 nausea and vomiting was not significantly different between the groups.

Regarding nausea and vomiting half an hour postoperatively in the recovery room, there was a significant difference among the groups ($p = 0.002$). Specifically, the ketamine and propofol groups had significantly less nausea and vomiting than the placebo group ($p = 0.013$).

In this study, patients with grade 3 and 4 nausea and vomiting were treated with 10 mg metoclopramide. Of the 49 patients in each group, 3 (6.1%) in the ketamine group, 4 (8.2%) in the propofol group, and 5 (10.2%) in the placebo group received intraoperative treatment. There was no significant difference among the groups in terms of metoclopramide intake ($p = 0.762$).

Patients with hypotension and bradycardia due to drug injection were treated with ephedrine or atropine. Of the 49 patients in each group, 22 (44.9%) in the ketamine group, 23 (46.9%) in the propofol group, and 31 (63.3%) in the placebo group received the aforementioned drugs. There was no significant difference among the groups in terms of the administration of the aforementioned drugs ($p = 0.137$). The average dose of injected atropine or ephedrine was 8.83 ± 7.14 mg in the ketamine group, 7.97 ± 6.42 mg in the propofol group, and 9.28 ± 9.59 mg in the placebo group. There was no significant difference among the groups in terms of the dosage of the aforementioned drugs ($p = 0.173$).

4. Discussion

In our study, mean age, mean weight, ASA, and other demographic information were not significantly different in all groups ($p > 0.05$). Additionally, there was a significant difference among the groups in terms of the incidence of intraoperative and postoperative shivering, with both ketamine and propofol being more effective than placebo in preventing shivering. In terms of grading, the intensity of shivering during surgery was not significantly different among the groups, but there were significant differences among the groups in terms of shivering in the recovery room half an hour after surgery. Ketamine was better than propofol in controlling postoperative shivering, and both ketamine and propofol were more effective than placebo in controlling postoperative shivering.

In our study, there was no significant difference among the groups in terms of shivering intensity during surgery when compared to the postoperative period in the recovery room. It can be considered that, since these drugs were injected after childbirth, there was little opportunity for the aforementioned drugs to exert

therapeutic effects. Additionally, despite the injections of ketamine and propofol, some patients continued to experience shivering and were treated with 25 mg of meperidine, which may be due to the different sites of action of meperidine in comparison to the studied drugs.

A study by Dal et al. [3] regarding the use of prophylactic ketamine in the prevention of postoperative shivering showed that the proportion of patients with shivering immediately after reaching the recovery room and at 10 and 20 minutes after surgery were significantly lower in the ketamine and meperidine groups than in the normal saline group. That study showed that prophylactic low-dose ketamine is useful in preventing postoperative shivering. The results of this study are in agreement with those of our study.

Likewise, a study by Cheong and Low [8] regarding the effect of propofol on post-anesthetic shivering showed that the prevalence of shivering in patients receiving propofol was significantly lower than in the control group. This finding is also consistent with the results of our study.

In a study by Kose et al. [9], which aimed to prevent shivering using prophylactic ketamine in patients undergoing cesarean section with spinal anesthesia, it was found that the incidence of shivering in the first and second groups receiving ketamine was less than that of the normal saline group. This study showed that 0.25 mg/kg prophylactic ketamine was effective in preventing of shivering in cesarean section by spinal anesthesia.

In a randomized controlled study by Lakhe et al. [15], 120 patients aged 18-65 years of American Society of Anesthesiologist (ASA) physical status I and II undergoing various surgical procedures were allocated alternately to one of the 4 groups: normal saline (Group 1), ondansetron 4mg (Group 2), ketamine 0.25mg/kg (Group 3) and tramadol 0.5mg/kg (Group 4). The results showed that prophylactic use of ondansetron and low doses of ketamine and tramadol are effective in preventing shivering post-spinal anesthesia without untoward effects. This finding is consistent with the results of our study.

In a study by Solhpour et al. [16], patients were randomly allocated to receive saline (placebo, group C), meperidine 0.4mg/kg (group Me), ketamine 0.25mg/kg plus midazolam 37.5µg/kg (group KMi), or meperidine 0.2mg/kg plus dexamethasone 0.1mg/kg (group MeD). All drugs were given via intravenous bolus immediately after intrathecal injection. Results showed that prophylactic use of meperidine 0.2mg/kg plus dexamethasone 0.1mg/kg was more effective than meperidine 0.4mg/kg or the combination of ketamine 0.25mg/kg and midazolam 37.5µg/kg in preventing shivering resulting from spinal anesthesia [16].

A comparative study by Singh et al. [17] on the effect of propofol and thiopental in postoperative shivering showed that propofol effectively reduces postoperative shivering. This finding corresponds with those of our study.

In another study by Dar et al. [18], patients were randomly allocated to receive either ketamine 0.25 mg/kg (Group K, n = 91) or normal saline (Group P, n = 92) 20 minutes before the completion of surgery. Tympanic temperature was measured before the induction of anesthesia, 30 minutes after induction, and before administration of the study drugs. Results showed that in the recovery room, no significant efficacy difference was observed between low-dose ketamine (0.25 mg/kg) and placebo in the prevention of postoperative shivering in patients who underwent orthopedic surgery. The findings of this study are not consistent with the findings of our study because other factors, such as preloading warm intravenous fluid, using active warming during surgery, and control of the room temperature, may help prevent shivering [19].

In the study by Rahmanian et al. [20] regarding low-dose intravenous ketamine effect on post-operative pain and complications after cesarean section, post-operative nausea and vomiting incidence was lower in the Ketamine group than in the placebo group. As a result, Ketamine significantly reduced post-operative nausea and vomiting after cesarean section [20].

Our study evaluated and recorded the frequency of nausea and vomiting during surgery and half an hour after surgery in the recovery room. There was no significant difference between groups in the incidence of nausea and vomiting during the operation. However, there was a significant difference between the groups in nausea and vomiting incidence half an hour after surgery in the recovery room. Findings showed that ketamine and Propofol play an effective role in controlling post-operative nausea and vomiting. There was no significant difference between the two groups in the Grading Scale of intraoperative nausea and vomiting. Half an hour after surgery in the recovery room, the severity of nausea and vomiting was significantly different between the groups. This suggests that ketamine and propofol were more effective in controlling postoperative nausea and vomiting than the placebo.

In a comparative study by Numazaki and Fujii [12] on the efficacy of a subhypnotic dose of propofol versus traditional antiemetic drugs in reducing the symptoms of nausea and vomiting in cesarean section, the antiemetic efficacy of a subhypnotic dose of propofol was comparable with 1.25 mg droperidol and 10 mg metoclopramide. The study also found that a subhypnotic dose of propofol was effective in preventing severe nausea. The results of this study were consistent with the results of our study [10].

In a study by Jin Sun Cho et al., which was a prospective, double-blind trial, 174 patients randomly

received ramosetron 0.3 mg (R0.3 group; n = 58), 0.45 mg (R0.45 group; n = 58), or 0.6 mg (R0.6 group; n = 58) at the end of surgery. The primary outcome that was measured was the incidence of postoperative nausea and vomiting (PONV) during the first 48 hours postoperative. Compared to ramosetron 0.3 mg, ramosetron 0.45 and 0.6 mg did not reduce PONV but reduced premature discontinuation of patient-controlled analgesia and increased patient satisfaction, without increasing adverse events [21].

In a study by Agarkar et al. [22], 206 patients with at least two risk factors for PONV were randomized to receive ramosetron 0.3 mg or ondansetron 8 mg 30 minutes before the end of surgery. Ramosetron 0.3 mg and ondansetron 8 mg were equally effective in reducing the incidence of PONV in high-risk patients [22].

A study by Yoshitaka Fujii et al. was a prospective, randomized and double-blind study to evaluate the efficacy and safety of a small dose of propofol alone, as well as propofol combined with dexamethasone, for the prevention of postoperative nausea and vomiting in adult Japanese patients receiving third molar extractions. They concluded that a small dose (0.5 mg/kg) of propofol combined with 8 mg examethasone was more effective than propofol alone for the prevention of postoperative nausea and vomiting in adult Japanese patients having general anesthesia for extractions of third molars [23]. This finding corresponds with the findings of our study.

Zade et al. [24] showed that the drug recipients in both groups were equally effective in preventing postoperative shivering.

5. Conclusion

According to the findings of our study, which was performed on patients undergoing elective cesarean section under spinal anesthesia, we can conclude that ketamine and propofol have an effective role in reducing both shivering and the incidence of nausea and vomiting after surgery. Considering the side effects of opioids, these drugs can be a good alternative for them. Like most studies, this one has some limitations, such as the short duration of patient follow-up. In future research, we recommend that more studies with larger sample sizes, longer follow-up periods and comparisons of different types of medication be performed. Also, the effect of these medications on different types of surgeries should be investigated simultaneously in one study as well as the effect of the duration of anesthesia on the incidence of shivering.

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