EFFECT OF FORCED AIR PREWARMING,TRAMADOL OR THEIR COMBINATION ON PREVENTION OF HYPOTHERMIA AND SHIVERING DURING CESAREAN SECTION UNDER SPINAL ANESTHESIA.

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ABSTRACT

Background and Objectives: Hypothermia and shivering are common side effects accompanying regional anesthesia Shivering occurs in up to 85% of patients undergoing cesarean delivery under spinal anesthesia and it has deleterious metabolic and cardiovascular effects. Therefore, hypothermia and shivering should ideally be prevented by pharmacologic or other means. We evaluated the efficacy of forced-air prewarming, tramadol or their combination in preventing perioperative maternal hypothermia and shivering in patients undergoing spinal anesthesia for cesarean section and effect on neonatal outcome. **Methods:** 105 patients undergoing elective cesarean section under spinal anesthesia were randomly assigned to three groups. Group T received Tramadol 1mg/Kg. I.V. with no prewarming. Group F received forced-air prewarming for 30 min. Group TF received Tramadol 0.5mg/Kg I.V. just before giving block plus forced-air prewarming for 20 min.. Core temperature (tympanic membrane) and the arm skin temperature were measured and shivering was graded simultaneously. Patients evaluated their Thermal comfort with visual analog scales. Rectal temperature, umbilical vein pH and Apgar score were measured in the infants after birth**. Results :** The core temperature was significantly lower in group T than in the two other pre-warmed groups (group F and group TF) at 30,45, 60, after intrathecal injection (P <0.05) with no difference between group F and TF.The mean skin temperature was statistically lower (P <0.05) in group T compared with groups F and TF until 60 minutes after intrathecal injection. Incidence of hypothermic patients was significantly less in F and TF groups being 5.7% in both groups compared to group T (60%), (P = 0.001) with lower necessity and shorter duration of active warming in groups F and TF. Shivering incidence was significantly higher in group T and group F being 23% and 25.7% respectively, compared to group TF being 0% (p<0.005). Patients received pethidine to control shivering were significantly low (0%) in Group TF compared to Groups T and F (p<0.05), with no difference between Groups T and F. Umbilical vein pH, rectal temperatures and apgar scores of the newborns were higher in babies of group F and TF (actively prewarmed mothers) than in the babies of group T (non pre-warmed mothers) (p<0.05) . **Conclusions:** The combined use of 20 min upper body forced air prewarming plus tramadol 0.5mg/Kg was more effective in preventing maternal core hypothermia and shivering and improving maternal thermal comfort and satisfaction with better neonatal outcome in patients undergoing cesarean delivery under spinal anesthesia compared with either prewarming for 30 min or tramadol 1 mg/Kg alone.

Keywords: Anaesthesia spinal, caesarean section, hypothermia, prewarming, shivering, tramadol,

INTRODUCTION

Hypothermia and shivering are common side effects accompanying regional anesthesia [1]. Spinal anaesthesia produces vasodilatation, which facilitates core to peripheral redistribution of heat. It also increases sweating threshold and decreases vasoconstriction and shivering threshold [2]. Mild perioperative core hypothermia may increase the risk of wound infection, bleeding, cardiac complications , and a prolonged postanesthesia care unit state [3] . Shivering occurs in up to 85% of patients undergoing cesarean delivery under spinal anesthesia [4] . Many factors had been suggested to contribute to the development of shivering.These include uninhibited spinal reflexes, postoperative pain, decrease sympathetic activity, pyrogen release, adrenal suppression, and respiratory alkalosis [5]. Shivering could have potentially detrimental effects including increased oxygen consumption and hypoxemia [6]. Shivering aggravates postoperative pain, impedes monitoring techniques, and is especially disturbing the mothers during labor and delivery [7]. Thus, prevention and management of hypothermia and shivering are essential. Various pharmacological and non-pharmacological [8] methods have been used in an attempt to maintain normothermia and to control post anesthetic shivering. Prewarming with Forced-air warming markedly increases peripheral tissue heat content and reduces the core to peripheral tissue temperature gradient, [9] thus helping in prevention or reduction of inadvertent perioperative hypothermia. Tramadol is an antishivering drug that inhibits the reuptake of 5-HT, norepinephrine, and dopamine and facilitates 5-HT release. It has been found effective in the prevention and treatment of shivering with less side effects than other μ-opioid agonists. [10] The aim of this study was to evaluate and compare the efficacy of forced-air prewarming, tramadol or their combination for prevention of perioperative maternal hypothermia and shivering during cesarean section under spinal anesthesia and their effect on neonatal outcome.

PATIENTS AND METHODS

After obtaining the approval of our Institutional Review Board and written informed consent from

the patients, one hundred five ASA grade I-II obstetrical patientsscheduled for elective lower segment cesarean section (LSCS) were enrolled into the study. Pregnant women who had contraindication to spinal anesthesia, those who had accompanying gestational hypertension, placenta previa, and twin pregnancy, those whose weight was < 50 kg or > 100 kg, those with fever, those with a recent history of any drugs except vitamins and minerals, and those who were converted to general anesthesia due to insufficient spinal anesthesia were excluded.

All patients were not premedicated and fasted for at least 8 h. Baseline blood pressure, pulse rate, SpO_2 electrocardiograph and core temperature (tympanic membrane) were recorded preoperatively in all patients. The operation and recovery rooms temperatures were adjusted at 22 ^{0}C throughout the surgery and in the recovery. All patients were preloaded with 0.9% sodium chloride 10 mL/kg transfused within 30 min before establishment of the subarachnoid block.

Core temperature was measured at the tympanic membrane continuously using a tympanic temperature sensor (YSI 400; Smiths Medical) , before and after prewarming , before and immediately after the completion of intrathecal injection and every 15 min after spinal anesthesia and every 10 min in the recovery room. In accordance with the current guidelines,

Hypothermia was defined as a core temperature < 36 ^{0}C [1,3,4].After completion of surgery, patients were shifted to the recovery room. In all groups, patients were covered with cotton blankets intra and postoperatively. However, active warming of the upper body was started if core temperature decreased below 36 ^{0}C .

The patients were allocated randomly using closed envelope technique to one of three groups:

Group T (n=35): Received Tramadol 1mg/Kg.I.V. just before giving block with no prewarming.

Group F(n=35): Received upper body preoperative forced-air warming for 30 min before giving block (Bair Hugger®; Augustine Medical, Eden Prairie, MN, Model 505 warming unit) set at 43 ^{0}C.

Group TF(n=35): Received Tramadol 0.5mg/Kg (I.V. just before giving block) plus active preoperative forced-air warming for 20 min before giving block.

Subarachnoid block was achieved under strict aseptic precautions in the left lateral position using a 27 G (Quincke's) needle introduced in the L_3 -L_4 intervertebral space. After obtaining a free flow of cerebrospinal fluid, 10 mg hyperbaric bupivacaine was injected in the subarachnoid space. The patient was made supine immediately and surgery commenced after achieving block level of T6. During the intraoperative period, patients were completely covered with surgical drapes. Vital parameters like NIBP, HR and SpO_2 were recorded every 2 min for the initial 10 min, followed by every 10 min till the end of surgery. When the systolic blood pressure dropped below 100 mmHg or decreased by more than 20% of the resting blood pressure, ephedrine 8 mg was intravenously injected.

Maternal data and observations, including core and skin temperature, nausea, vomiting, degree of shivering, thermal comfort, pain, heart rate, blood pressure, total fluids and blood loss were recorded. Umbilical vein blood from the infants was sampled for pH directly after birth. The rectal temperatures of the infants were recorded immediately after birth with a digital thermometer. A pediatrician determined Apgar scores of the infants 1 min after birth.

Shivering was graded during and after cesarean section using an existing scale [11]: 0 = no shivering; 1 = one or more of the following: piloerection, peripheral vasoconstriction or peripheral cyanosis without other cause, but without visible muscular activity; 2 = visible muscular activity confined to one muscle group, 3 = visible muscular activity in more than one muscle group; and 4 = gross muscular activity involving the whole body. If shivering grade ≥3 was observed after spinal anesthesia and administration of one of the studied methods, the patient was treated with IV meperidine 25 mg. Thermal comfort after cesarean delivery was evaluated with 100 mm VAS on which 0 mm was defined as insufferably hot, 50 mm as thermally neutral and 100 mm as worst imaginable cold. At the end of the study period, patients were asked to provide a satisfaction score for the quality of care using a verbal numerical scale (0 – 100, with 0 = extremely unsatisfied and 100 = extremely satisfied). Sedation score (0 = eyes open spontaneously, 1= eyes open to speech, 2 = eyes open when shaken, 3 = unarousable) was also recorded after surgery [12] .

STATISTICAL ANALYSIS

Based on the data from previous studies and using Biostatics program version 3.01, a study population of 35 patients for each group was needed to produce statistical power ≥ 90%, with α = 0.05 to detect a difference of 30% in the frequency of shivering during spinal anesthesia comparing group T with groups F and TF . Data values are presented as means (SD), median

(range) or number (percentage). Parametric data were analyzed by using one way ANOVA and Student's paired t-test where appropriate. Nonparametric data were analyzed using the Kruskal–Wallis test. P values <0.05 were considered statistically significant. Statistical analysis was performed using SPSS Windows version 13.0 (SPSS, Chicago, IL, USA).

RESULTS

There were no significant differences among the three groups regarding age, weight, height, gestational age, spinal level and duration of surgery (Table 1).

The changes in core temperature in each group are given in Fig. 1. In all three groupsthe core temperature decreased significantly from baseline, and it was significantly lower in group T than in the two other pre-warmed groups (group F and group TF) at 30,45, 60, after intrathecal injection (P <0.05).

30 min after intrathecal injection, the decrease in core temperatures of the two prewarmed groups (group F and group TF) was significantly less when compared to the non prewarmed patients (group T) (36.4 ^{0}C ± 0.3 ^{0}C and 36.5 ^{0}C ± 0.3 ^{0}C vs 35.9 ^{0}C ± 0.4 ^{0}C, respectively; P = 0.005) (Fig. 1). This significant difference continued up to the end of surgery and in the recovery. Core temperatures were not different between the two prewarmed groups (Fig. 1).

The mean skin temperature was statistically lower (P <0.05) in group T compared with the prewarmed groups (Group F and TF) during prewarming and until 60 minutes after intrathecal injection (Fig. 2). In all groups, the mean arm temperature reached a plateau of about 34.0°C after the patients were in the PACU.

21 patients out of 35 patients (60%) in(group T);tramadol 1mg/Kg IV with no prewarming, were hypothermic, whereas after 30 min prewarming (group F) or 20 min prewarming plus 0.5mg/Kg IV(group TF) only two out of 35 patients (5.7%) in both groups were hypothermic, P = 0.001. There were no significant differences between (group F) and (group TF). In the prewarmed groups, the necessity for active warming was lower, and the duration was shorter than in non prewarmed patients (group T) (Table 2).

The overall incidence of shivering was significantly higher in group T and group F being 23% and 25.7% respectively, compared to group TF being 0% (p<0.005). Grade 0 shivering was significantly high in groups TF (100%) compared to group T (77%) and group F(74.3%) (p<0.05), with no difference between Groups T and F. Grade 3 shivering was significantly high in Groups T and F compared to group TF (p<0.005), with no difference between Groups T and F. Patients received pethidine were significantly low in Groups TF compared to Group T and F (p<0.05), with no difference between Groups T and F (Table 2).

Thermal comfort scores were clinically lower in Group TF (49.0±10.1) than Group T (72.0±14.2) and F (66.2±12.5) (p<0.05). Satisfaction score was higher in group TF compared with group T (p<0.05). Sedation scores were not significantly different between the three groups. Immediately after birth, umbilical vein pH was higher in babies of actively heated mothers (Fig. 3). Furthermore, rectal temperatures of the newborns were higher in babies of group F and TF (actively prewarmed mothers) than in the babies with non prewarmed mothers (p<0.05)(group T). Apgar scores at one minute after delivery were higher in the prewarmed groups (group F and TF) than the non prewarmed group T (p<0.05). Apgar score 9 (8-9), 9 (8-9), and 8(8-9); median (range), respectively (Table 3).

Table 1. Demographic Data

	Group T (n=35)	**Group F (n=35)**	**Group TF (n=35)**
Age (yr)	34.5 ± 3.4	33.9 ± 4.6	33.8 ± 3.9
Weight (kg)	70.0 ± 11.6	69.0 ± 9.9	70.8 ± 10.4
Height (cm)	157.3 ± 6.4	159.6 ± 7.1	159.6 ± 5.6
Gestational age (day)	266.7 ± 5.3	266.9 ± 5.0	268.6 ± 5.5
Spinal level (thoracic)	T4 (T2-T6)	T4 (T2-T6)	T4 (T2-T6)
Duration of surgery (min)	45.5 ± 7.2	47.7 ± 6.5	49.0 ± 7.5

Table 2: Incidence, severity and duration of shivering, and number of patients received pethidine or active warming and its duration. Values are median (IQR [range]) or number (%)

	Group T	**Group F**	**Group TF**

	(n=35)	(n=35)	(n=35)
Shivering, n (%)	8 (23)	9 (25.7)	0 (0)*
Non shivering, n (%)	27 (77)	26 (74.3)	35 (100)*
Grades of shivering, n (%)			
Grade 0	27 (77)	26 (74.3)	35(100) *
Grade 1	0 (0)	0 (0)	0 (0)
Grade 2	3 (8.6)	2 (5.7)	0 (0)
Grade 3	5 (14.3)	6 (17.1)	0 (0) *
Grade 4	0 (0)	1 (2.8)	0 (0)
patients received pethidine for shivering, n (%)	5 (14.3)	7 (20)	0(0) *
Duration of shivering(min)	5.0(1.12)	6.5(1.5)	0(0) *
Patients required active warmingfor hypothermia, n (%)	21(60) #	2(5.7)	2(5.7)
Duration of active warming ; min	20[0-30(0-80)] #	0[0-0(0-30)]	0[0-0(0-25)]

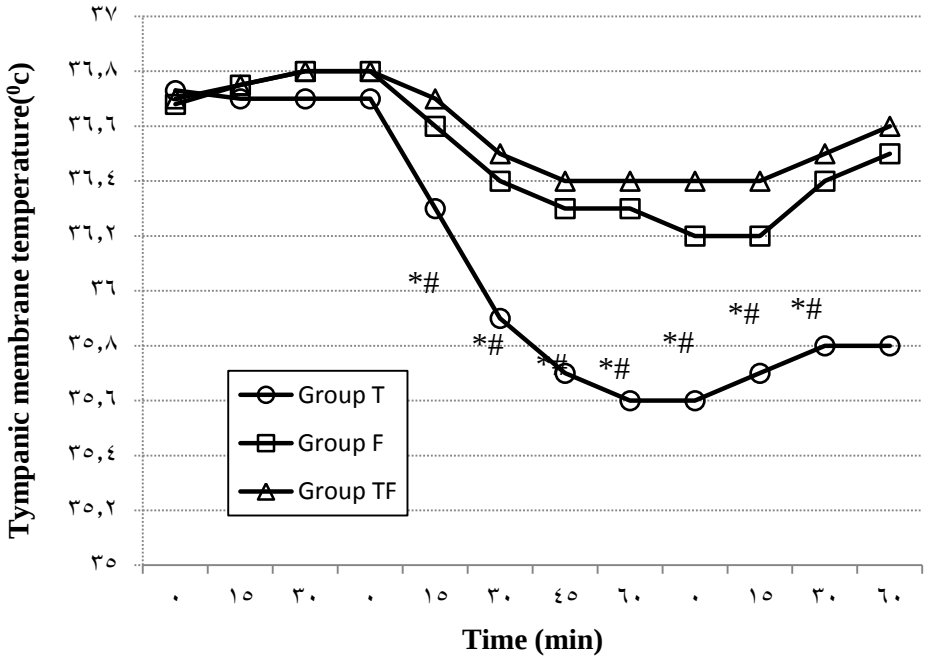
* p< 0.05 vs (groupT) and (groupF).
#p< 0.05 vs (groupF) and (groupTF)

Table 3: Maternal and babies data .

	Group T (n=35)	Group F (n=35)	GroupTF (n=35)
Thermal comfort (cold VAS)	72.0±14.2	66.2±12.5	49.0±10.1*
Sedation score	1(0-2)	0(0-0)	0(0-1)
Satisfaction score	70 (50-90)	90 (70-100)	100 (85-100)*
Initial baby rectal temperature (°C)	36.4 ± 0.7	37.1±0.5#	37.3 ± 0.6*
Umbilical vein pH	7.25 ± 0.06	7.30±0.06 #	7.32 ± 0.08*
Apgar score 1 min	8 (8-9)	9 (8-9) #	9 (8-9) *

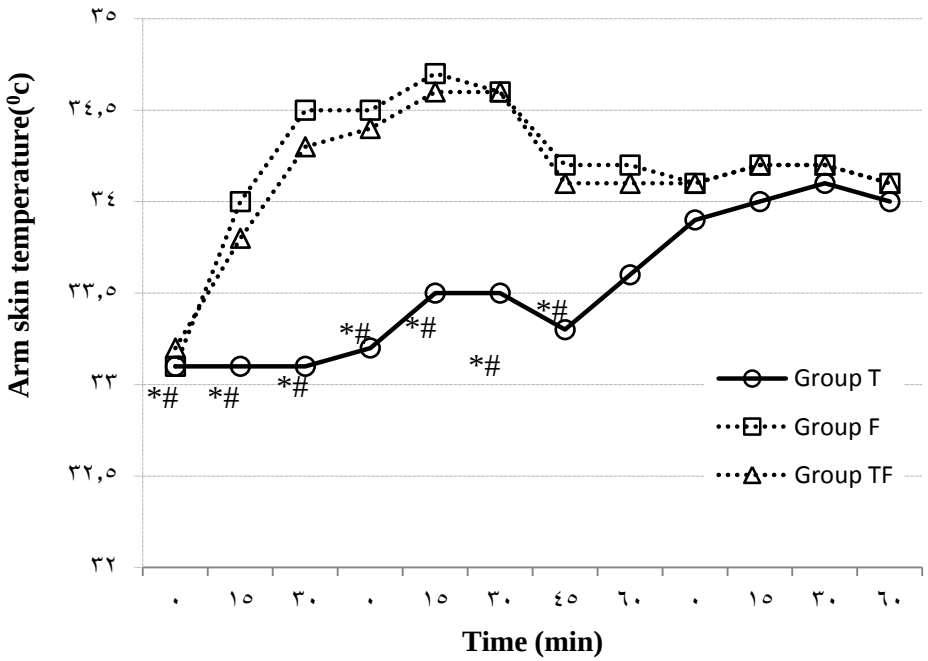
Values are mean ± SDor median (range),. *Statistically significant compared to groups T. #Statistically significant compared to group T

Figure 1. Pre, intra and postoperative tympanic membrane temperatures in the three groups. Pre-intrathecal injection (0, 15, 30 min), Time after intrathecal injection (0, 15, 30,45 and 60 min), followed by time in the PACU (0, 15,30, and 60 min).



* P < 0.05 compared with group F
\# P < 0.05 compared with group TF.

Figure 2. Pre, intra and postoperative arm skin temperatures in the three groups. Pre-intrathecal injection (0, 15, 30 min), Time after intrathecal injection (0, 15, 30,45 and 60 min), followed by time in the PACU (0, 15,30, and 60 min).



* P < 0.05 compared with group F
\# P < 0.05 compared with group TF.

DISCUSSION

In this study, the combined use of 20 min upper body forced air prewarming plus tramadol 0.5mg/Kg (group TF) or prewarming for 30 min (group F) had reduced the perioperative hypothermia with less decline in core temperature and higher rectal temperature, umbilical vein pH, and higher Apgar scores at one minute of the

newborn in prewarmed patients compared with tramadol 1 mg/Kg alone without prewarming (group T). Also the combined use of 20 min upper body forced air prewarming plus tramadol 0.5mg/Kg (groupTF) had prevented the perioperative shivering compared with either prewarming for 30 min or tramadol 1 mg/Kg alone. So the combined use of 20 min upper body forced air prewarming plus tramadol 0.5mg/Kg was more effective in preventing perioperative hypothermia and decreasing the incidence and severity of shivering with better neonatal outcome in patients undergoing cesarean delivery under spinal anesthesia compared with either prewarming for 30 min or tramadol 1 mg/Kg alone. An extensive search of the literature revealed no studies comparing tramadol with forced air prewarming or their combined use for prevention of postspinal hypothermia and shivering during cesarean section. Thus, this is the first attempt to compare tramadol with forced air prewarming or their combined use for prophylaxis of postspinal hypothermia and shivering during cesarean section.

Internal core to peripheral redistribution of body heat is usually the major initial cause of core hypothermia in patients with neuraxial anesthesia [13]. Neuraxial anesthesia also inhibits thermoregulatory control centrally and blocks peripheral sympathetic and motor nerve response, which prevents thermoregulatory vasoconstriction and shivering [14-16]. In addition, the shivering threshold is reduced by about 0.6 ^{0}C during spinal anesthesia [16]. The only available method of inhibiting the redistribution of heat is to decrease the temperature gradient between the peripheral and core thermal regions. To do this, active warming of the body is needed intraoperatively. In this study, forced air pre-warming for 20 or 30 min was sufficient to prevent core hypothermia , reduced incidence of hypothermic patients and the necessity for active warming was lower, and the duration was shorter, than in the patients who were not prewarmed . A previous study showed that patients undergoing cesarean delivery with epidural anesthesia experience less hypothermia and shivering if forced air-warming is used in the preoperative and intraoperative periods [17]. Prewarming hardly changes core temperature, which remains well regulated, but it markedly increases peripheral tissue heat content [9]. In agreement with our results , a recent study concluded that preoperative forced air-prewarming for15 min prevents hypothermia and shivering in patients undergoing elective cesarean delivery with spinal anesthesia [18].

Sessler et al. investigated the necessary time for effective pre-warming [19] and found that 30 min of forced-air warming increased tissue heat content more than previously demonstrated [20] and recommended a pre-warming period between 30 and 60 min. Also other clinical studies speculated that prewarming periods < 30 min could be sufficient [21] or confirmed that 30 min of prewarming combined with intraoperative warming can prevent hypothermia [22]. Our results regarding 20 and 30 min prewarming are in agreement with Cooper et al.'s review of different prewarming studies [23].

Intraoperative shivering during neuraxial anesthesia is triggered by various mechanisms including bodycore hypothermia caused by body heat loss and redistribution, heat loss exceeding metabolic heat production, and anesthetic-induced inhibition of centrally and peripherally mediated thermoregulatory control. Shivering was mostly accompanied by vasoconstriction and was thus consistent with thermoregulatory shivering [24]. The remainder was presumably non thermoregulatory muscular activity caused by uninhibited spinal reflexes and postoperative pain [25] and this explains why the combination of forced air prewarming and prophylactic tramadol were necessary for complete prevention of shivering. Spinal anesthesia has been shown to reduce the shivering threshold by impairing autonomic thermoregulation, with a resultant increase in apparent leg warming by blocking sensory input from the legs [26]. A previous study assessing the thermoregulatory responses to hypothermia in women undergoing spinal anesthesia showed that, when upper body skin temperatures were kept constant, the shivering threshold was significantly reduced compared with a control group [16].

In this study, the combined use of 20 min upper body forced air prewarming plus tramadol 0.5mg/Kg prevented shivering and no patient received pethidine compared with either prewarming for 30 min or tramadol 1 mg/Kg alone. This difference is consistent with the fact that both core and skin temperatures were significantly greater in the actively prewarmed patients.

Tramadol is an atypical opioid analgesic [27]. It prevents shivering by inhibiting the reuptake of norepinephrine and serotonin, hence activating the descending inhibitory spinal pathways. It also modulates the activity of nucleus magnus raphe acting centrally predominatly on the μ-opioid receptors with minimal effect on δ and κ receptors. The antishivering effect of tramadol is

probably mediated via its opioid or serotonergic and noradrenergic activity or both.

Talakaub et al [28] investigated tramadol for preventing postspinal shivering. They reported 3% incidence only of grade 3 or 4 shivering with tramadol pretreatment. However in this study, incidence of grade 2 and 3 shivering was 23% with tramadol only.Tramadol in doses of 1, 2 and 3 mg.kg−1 has been shown to be useful for prevention of postanaesthetic shivering [29, 30]. Mathews et al. compared tramadol in doses of 2 and 1 mg.kg−1 with normal saline for prevention of postanaesthetic shivering and found that the incidence of shivering was significantly lower in both tramadol groups compared to the control group [29]. De Witte et al. concluded that tramadol 3 mg.kg−1 given at the time of wound closure prevented postanaesthetic shivering in all the study patients [30]. Also in a previous study comparing intravenous tramadol 1, 2 and 3 mg.kg−1 for prophylaxis of postanaesthetic shivering, all three doses were effective in preventing postanaesthetic shivering as compared to the control group but only tramadol in doses of 2 and 3 mg.kg−1 was able to prevent significant shivering in 100% of the patients[10]. Chan et al.[31] stated that using tramadol IV at 0.25 mg/kg effectively controlled shivering during cesarean delivery during regional anesthesia with minimal side effects, while increasing tramadol dose to 0.5 mg/kg did not increase its therapeutic effects.

Previous studies have shown that intraoperative maternal forced air-warming is not beneficial in improving umbilical vein pH and Apgar score of the infants after birth [32, 33]. Also in a recent study [18] preoperative forced air prewarming failed to improve neonatal outcome (umbilical vein pH and Apgar score) . Our finding of higher values of rectal temperatures and umbilical vein pH of the babies in the prewarmed groups were consistent with the results of Horn et al. [17] who reported that preoperative forced air-warming combined with intraoperative warming improved the umbilical vein pH and rectal temperatures of the newborns without difference of Apgar score. Patient satisfaction was better in prewarmed groups and this in agreement with a previous study indicating that active warming improves it [34].

In conclusions, The combined use of 20 min upper body forced air prewarming plus prophylactic tramadol 0.5mg/Kg was more effective in preventing maternal core hypothermia and shivering and improving maternal thermal comfort and satisfaction with better neonatal outcome (in the form of preventing fetal hypothermia and improving umbilical vein PH and Apgar scores) in patients undergoing cesarean delivery under spinal anesthesia compared with either prewarming for 30 min or tramadol 1 mg/Kg alone. Prewarming seems most effective in preventing perioperative maternal hypothermia and shivering and improving neonatal outcome.

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