The Effects of a Hypothermia Prevention Program on the Body Temperature and Shivering in Women Undergoing Cesarean Section

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Abstract

Introduction and objective: Hypothermia is a common condition during general and spinal anesthesia which itself causes unpleasant complications including shivering, cardiovascular disorders, infection and delayed wound healing, coagulation disorders, delayed recovery, and prolonged hospitalization time. The present research aimed to study the effects of a hypothermia prevention program on the central body temperature and shivering in women undergoing a cesarean section.

Methodology: The present research was a quasi-experimental study in which 92 pregnant women undergoing cesarean section by spinal anesthesia in Ali-ibn Abi Talib Hospital of Zahedan during summer 2017 were purposively selected as the sample and randomly assigned to the intervention (hypothermia intervention program) and control (conventional care) groups. The participants were examined in terms of hypothermia and shivering and their central body temperature was measured 7 times. The obtained data were statistically analyzed using analysis of variance with repeated measures in SPSS-21.

Findings: The results showed that the pattern of body temperature changes over time was different in the two groups (p=0.001). The results also indicated that 23.9%, 30.4%, and 17.4% of patients in the control group experienced mild, moderate, and severe shivering, respectively. These figures for the intervention group were 6.5%, 19.6%, and 4.3%. These data suggest that there is a difference between the two groups in terms of shivering (p=0.001).

Conclusion: The study findings indicate that a hypothermia prevention program can greatly prevent the reduction in central body temperature and its complications, including shivering, in women undergoing a cesarean section. Hence, this inexpensive and effective care program is recommended to be used for patients undergoing major chest, abdominal, and pelvic surgery.

Key words: Hypothermia prevention program; Central body temperature; Cesarean section; Shivering

Introduction

Postoperative hypothermia, which refers to a decline in central body temperature below 36°C, is a serious and common complication caused by anesthesia and surgery that accompanies many postoperative side effects [1]. There are many risk factors for reduced body temperature during and after a surgery such as prolonged exposure of a large surface of skin and internal organs to cold air of operating room during the surgery [2], surgery type (opening of the chest, abdomen or pelvis), low ambient temperature of the operating room, infusion of a large volume of cold intravenous fluids, rinsing of the surgery site, breathing cold and dry gas and blowing cool air into the body cavities, duration of anesthesia, and female sex [3-5]. Recent studies have shown that more than 46% of patients undergoing abdominal or pelvic surgery develop hypothermia during the surgery that continues until entering the recovery room in one-third of them [6].

Shivering is a very important complication of hypothermia which occurs in about 40-60% of light anesthesia cases with different patterns of muscle activity [7]. In addition to increasing the oxygen consumption, shivering causes hypoxia, increased carbon dioxide production, blood pressure, intracranial pressure, intraocular pressure, intensified pain on the surgery site, and stitches opening [8].

In addition to shivering, other complications of hypothermia include cardiac ischemia, platelet and coagulation disorders, the susceptibility of surgical wounds to infection, a decrease in the metabolism of anesthetic drugs such as muscle relaxants, and prolonged hospitalization length [2, 9]. Many patients with hypothermia are complaining of cold after anesthesia as one of the worst surgical experiences [10]. Hypothermia prolongs the length of effect of inhaled and intravenous drugs as well as the duration of effect of nervous and muscle drugs [3].

Patients who are more prone to unintentional hypothermia include old people and children, female patients, patients with more risk of anesthesia (grades 3 to 4), and patients with cachexia, burn, adrenal glands failure, and hypothyroidism [11].

Caesarean section is one of the most common surgical procedures and its frequency from 4.5% of all deliveries in 1970 increased to 31.8% in 2007 [12-13].

Anesthetizing pregnant women for cesarean section, due to the effect of anesthetic drugs on vessels, body temperature regulation mechanisms, abdominal openness, and wetting of surgical coatings with blood and amniotic fluid, expose them to a further drop in body temperature [14].

Nowadays, different pharmaceutical and non-pharmaceutical solutions have been developed and used to prevent hypothermia. Some of these methods examined in previous studies include warming and moistening the air pathways [15, 16], warming the skin using warm coats [17], the use of a system of circulating water and compressed air [17, 18], infusion of warm intravenous fluids, and warm rinsing [15, 19, 20].

Diagnosis of postoperative hypothermia by nurses is essential for the safe management of patients [21]. Since patient support is one of the roles of nurses and this is the responsibility of operative and anesthetic nurses in the operating and recovery room [22], it is necessary to apply solutions to prevent hypothermia and shivering. Given that few studies have been conducted about the effects of several interventions simultaneously on the prevention of hypothermia and shivering, the authors, after reviewing the operating room and anesthesia nursing literature and guidelines recommended by the American Society of Peri-Anesthesia Nurses for the prevention of unwanted postoperative hypothermia, decided to perform a hypothermia prevention program consisting of three types of inexpensive nursing care (warm prep solution, infusion of warm liquids, and the use of a recovery bed for patient admission after the surgery) without complication in order to reduce the severity of postoperative hypothermia and shivering and take effective steps towards the promotion of health and comfort of patients and prevention of hypothermia complications. The present research aimed to study the effects of a hypothermia prevention program on the central body temperature and shivering in women undergoing cesarean section by spinal anesthesia.

Methodology

The present research was a quasi-experimental study, with a clinical trial code of IRCT20171002036505N1, which was conducted on pregnant women undergoing cesarean section in Ali-ibn Abi Talib Hospital of Zahedan in the period between July and September 2017, after approval by Deputy of Research and Technology and Ethics Committee of Zahedan University of Medical Sciences.

Based on the incidence of shivering in previous studies and considering a confidence level of 95% and a test power of 90%, the sample size of each group was calculated to be 42 using the following equation. In addition, after assuming the possible attrition, the sample size was determined to be 92 (46 in each group).

$$n = \frac{(z_1 - \frac{\alpha}{2} + z_1 - \beta)^2 \ [p_1(1-p_1) + p_2(1-p_2)]}{(p_1 - p_2)} = 41/38$$

The participants were selected using convenience sampling method and based on the inclusion and exclusion criteria. Then they were randomly assigned to the intervention and control groups. The inclusion criteria were non-use of corticosteroids, non-steroidal anti-inflammatory drugs, and magnesium sulfate; non-affliction with thyroid disorders, diabetes, cardiovascular diseases, chronic hypertension, and preeclampsia; termination of pregnancy at the time of term (37 to 42 weeks), no fever or addiction, non-rupture of amniotic sac, polyhydramnios, oligohydramnios, and existence of no precaution to control body temperature through the tympanic membrane. The exclusion criteria also included the occurrence of any condition that affects the normal course of anesthesia and surgery, receiving

blood and blood products during the surgery, a substantial drop in blood pressure during the surgery (20% lower than before anesthesia), and prolongation of surgery time (more than one hour).

Data collection tools included an information registration form (patient's personal information, type of surgery, and type of anesthesia) and a checklist for recording the desired parameters in operating and recovery rooms. The validity of the information registration form was assessed using content validity and based on the views and comments of some faculty members. The reliability of devices and monitoring was also determined by measuring their accuracy, calibration, and sensitivity. In addition, post-anesthetic shivering was measured using the scale described by Crossley and Mahajan: 0 = no shivering; 1 = no visible muscle activity but piloerection, peripheral vasoconstriction, or both are present (other causes excluded); 2 = muscle activity in only one muscle group; 3 = moderate muscular activity in more than one muscle group but not generalized shaking; 4 = violent muscular activity that involves the whole body [24].

After receiving the necessary permission from the Research Ethics Committee of Zahedan University of Medical Sciences and the head of Ali-ibn Abi Talib Hospital, the researcher visited the operating room of this hospital and briefed the medical staff on the research objective and procedure. The participants were randomly assigned to the intervention and control groups. Participants in the control group received the routine operating room care, including Prep, Drep, and infusion of fluids at room temperature, and then were transferred to the recovery room with a blanket cover. Central body temperature was measured 7 times including before the beginning of anesthesia, after the induction of anesthesia and before the surgery, 30 minutes after the beginning of surgery, after the surgery, at the beginning of recovery, 30 minutes after the beginning of recovery, and 1 hour after the beginning of recovery. The occurrence of shivering in patients in the recovery room was examined by an experienced anesthesiologist. After completing the control group, 46 pregnant women who met the inclusion criteria were selected for the intervention group. Participants in this group went through the desired intervention as follows:

- Before the intervention, the participants were briefed on objectives and methodology and then a written consent form was obtained from them.
- As soon as placing on the operating room bed, participants were prepared using povidone-iodine heated up to 32°C.
- Injectable fluids prescribed by the anesthesiologist were heated up to 38-40°C by a warmer (KAVOOSH MEGA) and then were infused.
- After the end of the surgery, the participants were transferred to the recovery bed which was prepared half an hour before the recovery according to the standard method and warmed by three hot water bags.
- The central body temperature of participants was measured 7 times the same as the control group. The tympanic membrane temperature was measured using a thermometer (EMPEROR) in accordance with standard methods.
- The temperature and humidity of the operating room, recovery room, and the corridors were measured during the surgeries using a thermometer and a humidity meter and were maintained in the range of 23-24°C and 50-55%, respectively.
- The obtained data were statistically analyzed in SPSS-21. The data were described using descriptive statistics (mean, frequency, standard deviation, and percentage). To compare quantitative and qualitative demographic variables between groups, independent t-test and chi-square were used, respectively. In addition, analysis of variance with repeated measures was used to determine the effectiveness of the intervention. All statistical analyses were performed at the 0.05 level of significance.

Findings

The results showed that there was no significant difference between the control and intervention groups in terms of age, gestational age, duration of surgery, temperature and humidity of the operating room and recovery room, and volume of serum received ($p>0.05$) (Table 1).

The central body temperature of mothers was measured 7 times and compared between the two groups (Table 2). The mean body temperature in the control group was 36.57°C after entering the operating room and reduced to 35.20°C 60 minutes after entering the recovery room. In the intervention group, these figures were 36.37°C and 36.32°C, respectively. The pattern of changes was not the same in the two groups and the reduction of mean body temperature in the control group was more than the intervention group. Except at the time of anesthesia induction that there was no significant difference between the two groups in the mean body temperature, it was significantly lower in the control group than the intervention group after the anesthesia induction until 60 minutes after entering the recovery.

The results of analysis of variance with repeated measures (Table 3) showed there was a significant difference between the control and intervention groups in terms of the mean body temperature ($f=37.56$, $df=1$, $p=0.001$), as the central body temperature of mothers in the control group was lower than that of the intervention group. This means that mothers who received the hypothermia prevention program during the surgery and recovery developed less hypothermia than those in the control group. On the other hand, the relationship between group and time was statistically significant ($f=394.961$, $df=1$, $p=0.001$). This suggests that the pattern of temperature variation was not the same in the two groups and its reduction was more in line with the occurrence of possible hypothermia in the control group. Therefore, it can be stated that the prevalence of hypothermia among mothers in the intervention group was lower than the control group. In fact, the hypothermia prevention program managed to cause a reduction in this condition during the cesarean section in the intervention group.

Table 1: Mean and standard deviation of individual and clinical characteristics of women undergoing cesarean section in intervention and control groups

Variable \ Group	Control Mean ± SD	Intervention Mean ± SD	Independent t-test result
Age (year)	32.48±7.229	30.63±7.362	P=0.8
Gestational age (week)	38.13±1.147	38.22±0.867	P=0.1
Serum volume (liter)	2.924±0.2349	3.098±0.3269	P=0.2
Surgery length	0.8833±0.21156	0.8957±0.20051	P=0.5

Table 2: Mean and standard deviation of central body temperature women undergoing cesarean section in intervention and control groups

Time \ Group	Control Mean ± SD	Intervention Mean ± SD
After entering the operating room	36.547±0.2832	36.374±0.3654
After the induction of anesthesia	36.417±0.3696	36.318±0.4307
30 minutes after the beginning of surgery	35.650±0.4718	36.057±0.4113
After the end of surgery	35.359±0.4712	35.904±0.4221
After entering the recovery room	35.300±0.5038	35.917±04291
30 minutes later	35.917±0.4291	36.165±0.4196
60 minutes later	35.207±0.4090	36.326±0.3165

Table 3: Analysis of variance with repeated measures on central body temperature of women undergoing cesarean section before, during, and after the intervention in intervention and control groups

Source of change	Sum of squares	Degree of freedom	Mean	Test statistic	Significance level	Impact size	Test power
Time	46.007	1	46.007	556.048	0.001	0.861	1
Time + Group	32.697	1	32.697	394.961	0.001	0.814	1
Error	7.447	90	0.083				
Group	37.080	1	37.080	37.560	0.001	0.294	1
Error	88.850	90	0.987				

Table 4: Frequency distribution of shivering among women undergoing cesarean section in intervention and control groups

Shivering level \ Group	Control		Intervention		Chi-square test result
	Frequency	Percentage	Frequency	Percentage	
No shivering	13	28.3	32	69.6	X^2= 17.281
Mild shivering	11	23.9	3	6.5	
Moderate shivering	14	30.4	9	19.6	P=0.001
Severe shivering	8	17.4	2	4.3	
Total	46	100	46	100	df=3

The highest frequency of shivering in the intervention group was related to "no shivering" (69.6%), and mild, moderate, and severe levels of shivering were observed in 6.5%, 19.6%, and 4.3% of participants in this group, respectively. In the control group, the highest frequency of shivering was found in the moderate level (30.4%). In addition, 23.9% and 17.4% of mothers experienced a mild and severe level of shivering and 28.3% of them had no shivering (Table 4). The results showed that the pattern of shivering was not the same in the two groups, as 33 mothers in the control groups had shivering in different levels but only 14 mothers in the intervention group experienced shivering of different levels. The results of chi-square test showed that there was a significant difference between the two groups in terms of the frequency distribution of shivering (p=0.001).

Discussion

The study findings showed that the application of a hypothermia prevention program can prevent the occurrence of hypothermia and thereby shivering, as the reduction in central body temperature during the surgery and at the recovery room was significantly lower in the intervention group than the control. In addition, the frequency of shivering presented a significant difference between the groups, as the hypothermia prevention program caused a reduction in the occurrence of both hypothermia and shivering in the intervention group. This is consistent with the findings of similar studies.

Yokayama et al. (2009) conducted a study on women under cesarean section by spinal anesthesia who received intravenous fluids of 40°C from the delivery until 45 minutes later and compared them with a group of control patients who were treated with serum at room temperature. Their results showed that the central body temperature of participants in the intervention group was significantly higher than those in the control group [25]. The consistency of findings can be attributed to the warming of intravenous fluids and similarity of the anesthesia method.

Abbasi et al. (2011) studied the effects of general anesthesia and spinal anesthesia on central body temperature of mother and infant in cesarean section. They used intravenous fluids heated up to 37°C during the surgery and maintained the room temperature at 26°C. Their results indicated that mothers and infants of none of the two groups developed hypothermia during the surgery, while mild hypothermia was observed in both groups in the recovery room [26]. The reason for no obvious drop in body temperature during the surgery is the infusion of warm fluids. However, due to the application of no method to prevent hypothermia in the recovery room, a temperature reduction was observed at this stage.

The findings of Volnov et al. (2009) also demonstrated that warming intravenous fluids in heating compartments is as effective as warming them by the Hot Line heater. They also showed that increasing the temperature of intravenous fluids up to 41°C and 45°C has greater effects on maintaining the body temperature of mothers higher, but this solution has no impact on postoperative shivering [27]. The consistency between the results of Volnov et al. and findings of the present study can be attributed to the heating of intravenous fluids. A similar study was conducted by Behdad on women undergoing a cesarean section and the results showed that heating the intravenous fluids by a warmer up to 37°C prevented the occurrence of shivering and hypothermia for half an hour and one hour after entering the recovery room [28].

Chuckler et al. (2014) studied the effects of heated resistance mattress on hypothermia in women undergoing a cesarean section and reported that the use of this mattress reduces the prevalence of unwanted postoperative hypothermia [29]. Ashwandi et al. (2014) and XU HX et al. (2010) also showed that the infusion of warm intravenous fluids prevents central body temperature drop and reduces the occurrence of post-anesthetic shivering in women undergoing a cesarean section or abdominal surgery [30, 31]. This is consistent with the findings of the present study. The study results also indicated that following the non-development of tangible hypothermia in women receiving the hypothermia prevention program, the incidence of shivering among them was significantly lower than those in the control group, as about 24% of participants in the intervention group and 48% of participants in the control group experienced a moderate and severe level of shivering. The results of several studies corroborate this finding. Ashwandi et al. (2011) showed that only 13% of women treated with warm serum felt shivering but 35% of women in the control group experienced shivering [32]. Troussian et al. (2015) conducted a systematic review study titled “Prevention of unwanted hypothermia complications during the surgeries” and stated that it’s better to actively warm up the patients 20-30 minutes before the surgery, and, if blood transfusion is required at a rate of 500 ml/hour, it’s better to warm the blood before transfusion. In addition, appropriate drugs can be prescribed in the case of shivering [33]. Dabir et al. (2010) showed that halothane, an anesthetic preservative, injection of higher volumes of intravenous crystalloids during surgery, and spinal anesthesia increases the risk of postanesthetic shivering in women’s surgical procedures, while hypothermia is not associated with shivering. In their study, no specific intervention other than routine care was performed and women undergoing different surgeries with different anesthetics and medications were studied. They reported that the overall prevalence of shivering among the participants was equal to 18.5% [34].

It is very necessary for nurses to be aware of physiological effects of hypothermia on patients undergoing a surgery and pay special attention to hemodynamic parameters of patients. In this regard, nurses can maintain the body temperature of patients before, during and after the surgery through precautionary measures and different techniques.

One of the limitations of this study was the possible instability of temperature and humidity in the operating and recovery rooms. However, it was tried to measure these variables using standard tools and maintain them in the normal range in coordination with the operating room staff. In addition, the occurrence of rare complications of surgery and anesthesia for patients was another limitation of this research, in this case, the patient was replaced by another one who met the inclusion criteria.

Conclusion

The hypothermia prevention program was effective in the control of hypothermia and shivering caused by spinal hypothermia in women undergoing a cesarean section. Considering the positive effect of hypothermia prevention program, it is recommended to use interventions to reduce the complications of postoperative hypothermia in a large number of patients. In addition, the effects of this preventive

program on the occurrence of hypothermia and shivering caused by surgeries in adults and children undergoing major abdominal and chest surgeries can be an area of research for future studies.

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