Assessing the effect of warming up the patient with forced air on the body central temperature during general anesthesia in patients aged 20-70 years under eye surgery in Farabi Hospital

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Abstract

Background and Objective: Lowering of body central temperature is a common phenomenon during general anesthesia, which can potentially lead to unwanted complications such as coagulation disorders, delayed wound healing, increased wound infections, and increased cardiac complications for patients. Therefore, the purpose of this study was to determine the effect of intensive heating of patients by forced air on raising central temperature during general anesthesia.

Materials and Methods: This clinical trial study was performed on 60 patients (41 males and 19 females) who were candidates for elective ocular surgery in Farabi Hospital. Participants were divided into 3 groups of 20 participants after obtaining informed consent. In this study, in the first group (pre-warming), the patients were warmed up for 30 minutes before anesthesia with forced air at 38-42°C. In the second group (control), warming was not performed and in the third group (total warming) warming up lasted half an hour before anesthesia until the end of anesthesia. The body central temperature of the patients was measured and recorded before the start of anesthesia and every 15 minutes during surgery and in recovery by means of a tympanic thermometer and finally was compared and statistically analyzed.

Results: The incidence of hypothermia in the pre warming group was 45%, in the control group 55%, and in the total warming group, 10%. Also, 10% of the pre-warming group and 15% of the control group experienced severe hypothermia. The mean body temperature of the patients except at the beginning of the study showed a significant difference at all times in the three groups. Also, patients who were exposed to active warming in the operating room had a higher mean temperature at recovery and at the outlet, and their differences were statistically significant ($p < 0.001$). There was no significant correlation between the body central temperature of the patients and their hemodynamic indices over time.

Discussion and Conclusion: In this study, it was shown that the active warming of the patients in the operating room prevents reduced body central temperature. Also, the warming of the patients for a short time prevents the occurrence of hypothermia.

Key words: Hypothermia, active warming, forced air warming, general anesthesia

Please cite this article as: Maleki A. et al. Assessing the effect of warming up the patient with forced air on the body central temperature during general anesthesia in patients aged 20-70 years under eye surgery in Farabi Hospital. World Family Medicine. 2018; 16(1):48-54
DOI: 10.5742/MEWFM.2018.93196

Introduction

Body temperature is regulated by the central nervous system (hypothalamus). Heat information comes from deep skin and tissues; sensitive to cold cells and heat sensitive cells that are physiologically and anatomically different. As a result of heat, impulses that emanate from heat receptors are increased, and the cold receptors emit more impulse due to cold. General anesthesia reduces the temperature threshold for shivering and vasoconstriction by about 2-3 degrees. Disturbances in temperature setting responses, along with operating room coolness, makes patients more prone (vulnerable) to hypothermia. Reduction in body temperature after the onset of general anesthesia is a common problem, due both to the impairment of the thermoregulatory response and the lowering of the operating room temperature. Loss of temperature (heat) in the operating room is possible in 4 ways:

1) Evaporation; which occurs after evaporation from the patient's body surface
2) Radiation; the patient's body emits heat (temperature) to the environment
3) Conduction; the heat (temperature) is transmitted to the surfaces in contact with the patient's body (such as a bed, etc.)
4) Convection; in which the heat (temperature) is lost through the convective heat flow

The combination of these losses simultaneously through disrupting thermoregulation and receiving of intravenous fluids predisposes the patient to hypothermia during anesthesia.

The body's response to reducing temperature is through ways that increase heat production or reduce heat loss from the environment. Lower energy consumption modes, such as vasoconstriction, occur sooner than shivering. Due to anesthesia, the temperature control mechanisms are disrupted, and in addition, the operating room coolness and the extent of the surgery helps to lose heat. Reducing central temperature below 36 ° C is considered hypothermia and reduction to below 35 ° C as severe hypothermia. Estimates show that 50-90% of patients undergoing small and large surgery are prone to experiencing hypothermia (1).

This decrease in body temperature causes many complications, such as postoperative shivering which increases the oxygen consumption by a factor of several times, which may be problematic, especially in the case of heart problems, leading to post-operative myocardial ischemia and angina (2). Hypothermia can cause coagulation disorder, as well as increased susceptibility to infection and delayed wound healing. Increased hospitalization time and increased mortality within the hospital are considered as a significant complication of hypothermia (3).

Warming patients during anesthesia is performed by using forced air or warm-up blankets and aqueous systems (4, 5 and 6). For example, in a study by E. Benson on the effects of active scrubs heater on body temperature regulation and postoperative pain reduction in patients undergoing TKA surgery, it was shown that a group of patients with active scrubs heater had higher temperatures in the post-anesthetic care unit and less need for opioids than those who used standard cushions (1). In another study by Anupama Wadhwa on the comparison of different warm-up methods, circulating water systems and forced air were compared. The findings indicated that circulating water systems warmed-up volunteers to hypothermia in a lesser time (7). Finally, in a study by Horn on the effects of short-term warm-up periods in preventing the formation of post-surgical hypothermia, there was a significant difference in the body central temperature between the warmed-up and non- warmed-up groups. Without warming-up 69% of the patients were hypothermic after anesthesia, while 8%, 7% and 6% of patients who were warmed-up for 30, 20 and 10 minutes, experienced hypothermia (8).

Considering that maintaining body temperature plays a very important role in health and reducing patient dissatisfaction during anesthesia and continuing treatment, as a result, we decided to design a study and investigate this method that can be used to prevent temperature loss during anesthesia. The aim of this study was to evaluate the effect of pre-warming and total warming using forced air method on the body temperature of patients undergoing elective ocular surgery. Also, the effect of body temperature on the hemodynamic status of patients and the incidence of PAS were evaluated. The purpose of this clinical trial was to determine the effect of warming-up patients on the reduction of body central temperature during surgery.

Materials and Methods

In this study, 60 patients aged 30-70 years old with ASA I-II candidate for elective ocular surgery (Retina, cataract) under general anesthesia were divided into three groups of 20, after obtaining written consent for participation in the study. Patients with any history of diabetes, hypothyroidism, hyperthyroidism and hypertension were excluded from the study.

In this randomized study, the intervention group was warmed up in the first group 30 minutes before anesthesia with forced air at a temperature of 38-42 ° C (pre-warming). In the second group, the control group, warming- up was not done.

In the third group, warming-up was performed throughout the whole period of surgery (total warming).

In each of the three groups, premedication was performed with 0.03 mg / kg Midazolam and 2 mic / kg fentanyl and after induction anesthesia was performed with 2 mg / kg propofol and 0.5 mg / kg atracurium. After 3 minutes, the patient was intubated by anesthesiologist and was connected to the ventilator and the anesthesia was continued with isoflurane 1.5% in oxygen 100%.

Patients' body temperature, hemodynamic profile and operating room temperature were measured every 15

minutes by tympanic thermometer and operating room thermometer and was recorded in the data collection form. The duration of surgery was considered to be 90 minutes for each of the three groups. The hemodynamic characteristics of the patient, including heart rate and mean arterial pressure, at the same time as taking the temperature, was recorded in the form. Other variables including age, sex, surgical duration and weight were also recorded with the patient's records. Also, in the recovery room, the shivering incidence was evaluated and registered. Finally, after the surgery, the patient was re-evaluated in the PACU and the recovery temperature (the temperature of entering the care unit after anesthesia) as well as the patients' body temperature at the exit temperature was obtained and registered.

The data were analyzed using SPSS software version 20 and the percentage of frequency, statistical indexes such as the mean and dispersion indexes such as standard deviation, were calculated for the data.

Findings

In this study, 41 males and 19 females were examined. Of the total number of men, 12 people (29.3%) in the pre-warming group, 15 people (36.3%) in the group without warming and 14 people (34.1%) in the total warming group, and the total number of women examined (8) people (42.1%) in the pre-warming group, 5 people (26.3%) in the group without warming and in 6 people (31.6%) the total warming group were evaluated. The mean and standard deviation of weight, age, and operating room temperature are presented in Table 1. No significant difference was found between the three groups in these variables.

Table 1: Mean and standard deviation of weight, age and operating room temperature

Group		Age (year)	Weight (kg)	Room temperature (C)
	P value	0.09	0.5	0.5
Pre warming	Mean	44.1	73	24.88
	SD	14.8	12.4	2.05
Without warming	Mean	36.6	69.7	25.61
	SD	15.7	9	2.17
Total warming	Mean	27.5	72.8	25.28
	SD	17.3	12.2	1.86
Total	Mean	42.7	71.8	25.5
	SD	16.3	11.2	2.02

The mean and standard deviation of patients' body temperature in the sequence of the study in the three groups are presented in Table 2. The mean body temperature of patients showed a significant difference except for the beginning of the study at all times in the three groups. The incidence of hypothermia was 10% in the pre-warming group, 55% in the control group and 10% in total warming. Also, 10% of the pre-warming group and 15% of the control group experienced severe hypothermia.

Table 2: Mean and standard deviation of patients' body temperature in the study sequence

Group		Patient's body temperature on admission	The first examination of the patient's body temperature	The second examination of the patient's body temperature	The third examination of the patient's body temperature	The fourth examination of the patient's body temperature	The fifth examination of the patient's body temperature
	P value	0.5	0.00	0.00	0.00	0.00	0.00
Pre warming	Mean	36.62	36.3	36.2	36	36	35.9
	SD	0.30	0.6	0.6	0.6	0.7	0.8
Without warming	Mean	36.70	36.2	35.9	35.7	25.7	35.3
	SD	0.31	0.6	0.6	0.6	0.6	0.6
Total warming	Mean	36.76	36.7	36.6	36.6	36.6	36.8
	SD	0.30	0.6	0.6	0.6	0.7	0.8
Total	Mean	36.6	36.4	35.9	36.2	36.1	36.2
	SD	0.30	0.6	0.6	0.6	0.6	0.6

The mean and standard deviation of patient body temperature during recovery and discharge from the operating room in the three groups were as follows (Table 3). As can be seen, the mean body temperature of patients in recovery and discharge time also showed a significant difference in the three groups.

Table 3: Mean and standard deviation of patient's body temperature during recovery and discharge from the operating room

Group		The patient's body temperature range at the entrance to the recovery room	Patient body temperature when leaving the operating room
	P value	0.00	0.00
Pre warming	Mean	36	36.4
	SD	0.7	0.3
Without warming	Mean	35.8	36.2
	SD	0.6	0.6
Total warming	Mean	36.6	36.7
	SD	0.4	0.3
Total	Mean	36.1	36.4
	SD	0.7	0.5

The mean and standard deviation of patients' blood pressure in the study sequence in the three groups are presented in Table 4. As can be seen, the mean of blood pressure in patients did not show any significant difference at all times in the three groups.

Table 4: Mean and standard deviation of blood pressure in patients in the study sequence

Group		Patient's blood pressure on admission	The first examination of the patient's blood pressure	The second examination of the patient's blood pressure	The third examination of the patient's blood pressure	The fourth examination of the patient's blood pressure	The fifth examination of the patient's blood pressure
	P value	0.54	0.80	0.83	0.71	0.49	0.40
Pre warming	Mean	86.95	76.95	75.65	71.85	77.60	78.80
	SD	16.02	19.04	12.83	13.52	13.43	5.75
Without warming	Mean	88.15	79.25	77.70	74.15	76	75
	SD	19.01	20	16.30	11.88	21.13	12.12
Total warming	Mean	82.10	74.90	78.40	75.20	81.25	73.30
	SD	19.60	23.09	15.19	13.74	15.79	11.02
Total	Mean	85.73	77.03	77.25	73.73	78.28	75.87
	SD	18.16	20.50	14.64	12.93	14.12	9.16

The mean and standard deviation of patients' heart rate in the study sequence in the three groups are presented in Table 5. As can be seen, mean heart rate of patients did not show significant difference at all times in the three groups.

Table 5 Mean and standard deviation of heart rate of patients in the study sequence

Group		Patient's heart rate on admission	The first examination of the patient's blood pressure	The second examination of the patient's heart rate	The third examination of the patient's heart rate	The fourth examination of the patient's heart rate	The fifth examination of the patient's heart rate
	P value	0.69	0.74	0.18	0.55	0.05	0.26
Pre warming	Mean	0.78	87.35	87.30	84.85	82.75	88.60
	SD	13.60	15.93	9.76	12.57	10.68	10.38
Without warming	Mean	81.65	88.75	91.80	88.40	91.15	83.67
	SD	15.50	15.05	12.25	10.56	9.85	8.39
Total warming	Mean	79.50	85.25	85.30	85	85.65	93.18
	SD	11.54	12.73	11.61	11.64	11.25	8.70
Total	Mean	79.72	87.12	88.13	86.08	86.52	90.08
	SD	13.49	14.45	11.40	11.54	11	9.60

Analysis of variance with repeated measurements showed that age, weight, operating room temperature, blood pressure, heart rate, patient body temperature at the time of entry (admission), and the first, second and fourth examination of the body temperature, recovery, body temperature at discharge, the first, second and fourth examination of blood pressure and second, third, fourth and fifth examination of the heart rate, did not show a significant difference in the three groups studied over time. In analyzing these cases alone, in three groups, analysis of variance with repeated measurements again showed that only four variables of the second and fourth times of the body temperature examination and the first examination of blood pressure and the third examination of heart rate showed no significant difference in the three groups over time (Table 6).

Table 6: Analysis of variance with repeated measurements of mean and standard deviation of body temperature, blood pressure and heart rate in the study sequence

Effect	Value (amount)	F	Significance
Time	Pillai's Trace	427.72	0.00
	Wilks Lambda	427.72	0.00
	Hotelling's Trace	427.72	0.00
	Roy's Largest Root	427.72	0.00
Interaction between time and group	Pillai's Trace	1.37	0.22
	Wilks Lambda	1.39	0.22
	Hotelling's Trace	1.40	0.21
	Roy's Largest Root	2.74	0.05

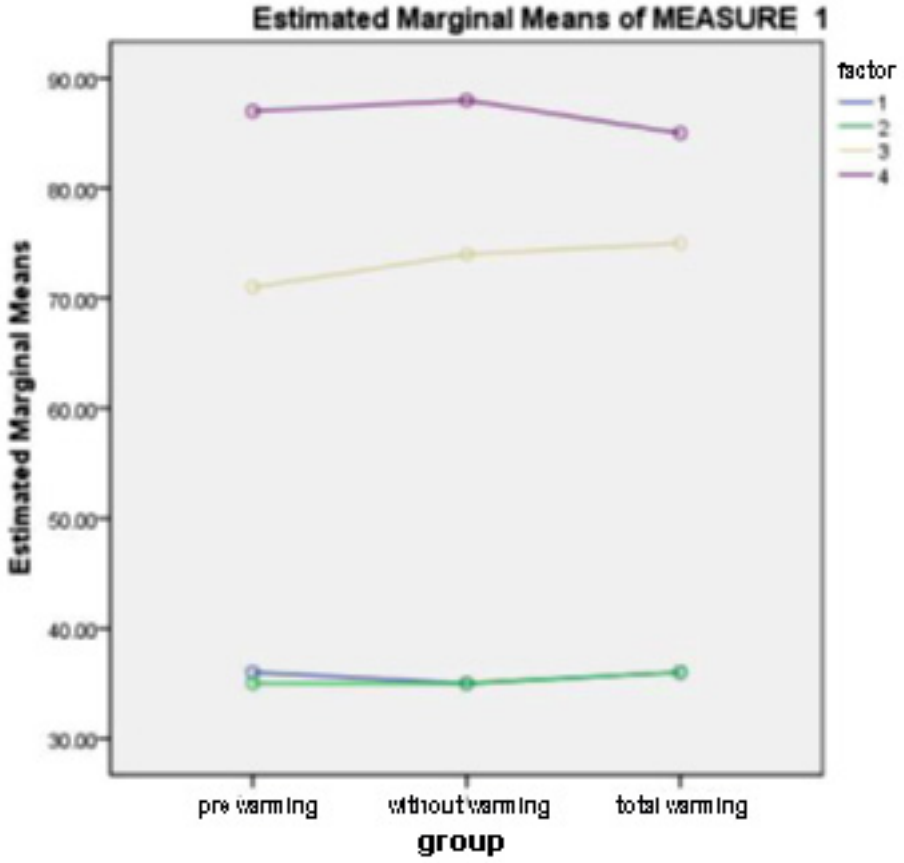
Table 7: Analysis of the variance of intra-group effects

Source of change		Sum of squares	df	Mean of squares	F	Significance level
Time	Linear	108651.78	1	108651.78	1008.75	0.00
	Quadratic	2742.53	1	2742.53	30.79	0.00
	Cubic	11547.50	1	11547.50	137.54	0.00
Interaction between time and group	Linear	79.57	2	39.78	0.36	0.01
	Quadratic	91.40	2	45.70	0.51	0.01
	Cubic	58.24	2	29.12	0.34	0.01
Error	Linear	6139.39	57	107.70		
	Quadratic	5076.19	57	26.73		
	Cubic	4785.42	57	48.55		

Table 8: Analysis of the variance of out-group effects

Source of change	Sum of squares	df	F	Significance level
Fixed (constant)	815512.07	1	7782.27	0.00
Group	25.43	2	0.12	0.88
Error	5973.08	57		

Diagram 1: Comparison of the mean and standard deviation of the scores of the studied patients in the three groups in the study sequence



Discussion and Conclusion

Reducing central temperature below 36 ° C is considered as hypothermia and reduction to below 35 ° C as severe hypothermia. Estimates show that 90-90% of patients undergoing small and large surgery are prone to experiencing hypothermia (1). The incidence of hypothermia can cause a series of unwanted side effects in patients undergoing surgery, such as postoperative shivering which increases the oxygen consumption by several times, which may be problematic, especially in cases of cardiac problems, leading to myocardial ischemia and angina after surgery (2). Hypothermia can cause coagulation disorder, as well as increased susceptibility to infection and delayed wound healing. Increased hospitalization time and increased mortality within the hospital are considered as a significant complication of hypothermia (3).

Regarding this important condition, many studies have been carried out about the factors affecting hypothermia and various ways to prevent hypothermia (1, 7-10). So that by warming up the patients actively by water and forced air the occurrence of hypothermia and its complications can be prevented. In De Witte's study, among 27 patients divided into 3 groups, it was shown that those who were warmed-up by resistive heating for 30 minutes before receiving the anesthetic had a higher temperature than those in the control group, but those using the forced air were not very different from the control group (9). Another study by Sebastian Brandt and colleagues was conducted comparing two methods of heating in orthopedic patients. In this study, on 80 patients who underwent orthopedic surgery two methods of forced air and resistive-polymer (RP) were compared in which the warming-up by RP was shown to be as effective as forced air (10).

Of course, pre-warming has also been effective and patients in this group have a higher temperature than the control group, which has led to similar results in previous studies. Patients undergoing active warming-up during the entire period of surgery showed a significant increase in temperature compared to the pre-warming group.

Patients who were exposed to active warming-up in the operating room had a higher temperature at the time of entry into the recovery room and when leaving the operating room, which was interpreted as statistically significant. In this design, shivering was not seen in any of the 3 groups. In previous studies, shivering was reported to be 3.5 to 14.4 (11, 12). It seems that the age of the studied population, the type of surgery (given that eye surgery is limited and with low bleeding) and warming up of patients are the causes of this finding in our study.

On the other hand, by analyzing other variables in the study, we concluded that age and weight of patients did not show significant correlation with body temperature during anesthesia. Also, by performing repeat measurement analysis, it was shown that there was no significant correlation between patient body temperature and hemodynamic indexes over time.

In general, in our study on the effect of warming-up the patients during surgery was investigated, and it was shown that active warming-up can prevent the occurrence

of unwanted hypothermia in patients undergoing GA. However, the incidence of adverse effects was not investigated. Future studies can address the effect of hypothermia on the incidence of complications of hypothermia (hemorrhage (bleeding), cardiac ischemia, wound infection, etc.). Of course, the realization of this issue requires the cooperation of surgeons in other fields. Also, due to the inaccessibility of a warmer in the routine room, the necessity of examining the effectiveness of the existing equipment and design of the heating (warming) devices of patients with a reasonable quality seems reasonable. On the other hand, given the complications of hypothermia, some studies may be designed to reduce the incidence of hypothermia, which could reduce the unwanted costs imposed on patients.

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