Postoperative Hypothermia Control: Effect of Electric and Woolen Blanket

Ameliyat Sonrası Hipotermi Kontrolü: Elektrikli ve Yün Battaniye Etkisi

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ABSTRACT

Postoperative hypothermia is very common in elderly patients. It causes severe surgical complications resulting in depletion of reserves in total knee arthroplasty (TKA) patients. Normothermia should, therefore, be maintained in those patients. Purpose was to determine the effect of using both electric and woolen blankets on the management of postoperative hypothermia in TKA patients. This experimental study was conducted in a public hospital in Turkey. The study sample consisted of 46 patients equally divided into two groups. Experimental participants used both electric and wool blankets while control participants received routine care. Body temperature, feeling cold, and shivering were repeatedly measured before and after surgery. Control participants had significantly higher body temperatures in their rooms after surgery and in the first 15 minutes than experimental participants. Experimental participants showed a more rapid rise in body temperature than control participants. Using both wool and electric blankets increased body temperature.

Keywords: Hypothermia, Postoperative period, Heating method, Aged.

ÖZ

Postoperatif hipotermi yaşlı hastalarda çok yaygındır. Total diz artroplastisi (TDA) hastalarında rezervlerin tükenmesine neden olan ciddi cerrahi komplikasyonlara neden olur. Bu nedenle bu hastalarda normotermi korunmalıdır. Amaç, TDA hastalarında postoperatif hipoterminin yönetiminde hem elektrikli hem de yün battaniye kullanımının etkisini belirlemekti. Bu deneysel çalışma Türkiye'de bir devlet hastanesinde yapıldı. Çalışmanın örneklemini eşit olarak iki gruba ayrılan 46 hasta oluşturdu. Deneysel katılımcılar hem elektrikli hem de yün battaniye kullanırken, kontrol katılımcıları rutin bakım aldı. Vücut ısısı, üşüme ve titreme ameliyattan önce ve sonra tekrar tekrar ölçüldü. Kontrol katılımcıları, ameliyattan sonra ve ilk 15 dakikada odalarında deney katılımcılarına göre önemli ölçüde daha yüksek vücut sıcaklıklarına sahipti. Deneysel katılımcılar, vücut sıcaklığında kontrol katılımcılarına göre daha hızlı bir artış gösterdi. Hem yün hem de elektrikli battaniye kullanmak vücut ısısını artırdı.

A**nahtar Kelimeler:** Hipotermi, Postoperatif dönem, Isıtma yöntemi, Yaşlı

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INTRODUCTION

Mild hypothermia, which is very common among patients in the postoperative period, causes an increase in pulse, peripheral vascular resistance, blood pressure, central venous pressure, cardiac output and shivering, while it decreases thermal comfort. Hypoperfusion, which is caused by hypothermia, may also cause many problems such as bleeding, surgical site infections, an extended hospital stay and accordingly, an increase in the rate of morbidity and even mortality.[1,2] The older people are one of the risk groups in terms of the development of hypothermia. As the thermoregulation mechanism is slowed down in older people, they get more prone to hypothermia.[3]

Hypothermia can also develop in the older people after total knee arthroplasty (TKA), which is frequently performed in this age group due to rheumatoid arthritis, osteoarthritis, osteoporosis, etc.[4] TKA is also a large-scale surgical intervention. Moreover, some complications during TKA surgery such as bleeding, infection, deep vein thrombosis and pulmonary thromboembolism may be aggravated by hypothermia.[5] A central body temperature of 37 ^{0}C prior to a TKA operation may decrease to 33^{0}C after the operation.[6,7]

Hypothermia causing more severe surgical complications in the preoperative and postoperative period of the older people leads to a depletion of reserves in the older people undergoing TKA and, it is difficult to return to a preoperative state. Therefore, nurses should try to make patients normothermic by using effective heating techniques. The relevant literature indicates that active and passive heating techniques are used to control hypothermia.[8-13] Active heating techniques are based on the principle of providing exterior heat to the patient; they include the use of air and water heaters, electric blankets, radiant heaters and waterbeds. In some studies, the most effective way of controlling perioperative hypothermia was to heat the skin using hot-air blowers. However, the cost-effectiveness of hot-air blowers has still not been proved.[14] Passive heating techniques aim to control hypothermia by preventing loss of temperature and preserving current body temperature. The effectiveness of passive heating techniques is based on the thickness of the layer of air between the sheets used to heat the patient and/or preserve the current body temperature and the patient's skin. The covered part of the body and the preserved and/or gained heat are consistent with each other in passive heating techniques. Blankets are made of wool, cotton, acrylic or polyester.[15,16] Although a variety of raw materials are used to produce blankets, previous studies have been conducted about using of cotton blankets.[17]

The studies have reported that cotton blankets, a passive heating technique, preserved body temperature did not increase it. Thus, it is suggested that passive heating techniques be used together with active heating methods.[18-21] In addition, a review of the literature on materials used for the production of sheets revealed that sheets made of wool were better than cotton sheets in some aspects such as the preservation of temperature and the removal of steam. It was found that the thermal conductivity coefficient of woolen materials was smaller than that of cotton materials.[22] Thus, the thermal conductivity of woolen is better than that of cotton in a wet environment.[23] Additionally, it is suggested that one of the active heating methods be used along with covering the patient with a blanket. However, it is still not clear which active heating method should be used.[24-27] Further, alternative methods are needed to heat the patients since it is not applicable to older patients who had TKA surgery to wear special apparatus which is connected to the heater fan in the early postoperative period.[27]

Based on our literature review, it is clear that hypothermia for patients undergoing surgery is an important problem and exploration of the best practice for hypothermia control is necessary. In Turkey, research on hypothermia control is limited in the available literature, and our observation indicates that cotton blankets and electric blankets are used for hypothermia control of

the patients after surgery. Therefore, the objective of this study was to determine the effectiveness of woolen blankets in addition to electric blankets to control hypothermia in the postoperative period in patients who have undergone TKA.

MATERIAL AND METHODS

As an experimental design with repeated measures to test the following hypothesis: the average body temperature of patients who use an electric blanket along with a woolen blanket reaches a normal value at least one timeframe (15 minutes) before that of patients who use a woolen blanket. It was used electric blankets for the patients in the experimental group in addition to the routine practices in the clinic and did the routine practice in the clinic for the patients in the control group by the researcher. The routine practice consists a mattress under and a woolen blanket on top of the patient.

Setting

The study was conducted in the orthopedic clinic of a public hospital in Turkey with the capacity to serve 100.000 patients, where approximately 250 TKA operations are performed per year.

Sample

Sample of the study included patients who had TKA under spinal and/or epidural anesthesia. Sample size calculation was performed using the Number Cruncher Statistical System (NCSS)–Power Analysis and Sample Size (PASS) software. Based on the differences in the mean scores of body temperatures for seven different times (before surgery, taking to their beds after surgery, 15^{th} minutes, 30^{th} minutes, 45^{th} minutes, 60^{th} minutes and 75^{th} minutes after surgery) obtained from the patients in the pilot study, the alpha level was set at 0,05, effect size was set as 0,25 and power as 80%. With these parameters, the samples were calculated as 21 control and 21 experimental group. Thus, 23 patients were included in each group (23 patients in the experimental group and 23 patients in the control group) after the groups were stratified according to age and gender. Pilot observations were included in the analysis. In the pilot study, it was determined whether there is a difference between the control and experiment groups in terms of dependent variables and control variables. The patients were selected with quota sampling according to age and gender (each group: male: 4, female: 9 between 60- 69 ages; male: 3, female: 7 between 70-79 ages) and were randomized according to days of the week.

The inclusion criteria for this study were: being between the ages of 60 to 79, having an SPO_2 value above 90% when they were hospitalized, no having diseases affecting cognitive functions or thermoregulation due to systemic effects, and no using any medication which could effect thermoregulation. The patients with dementia (n: 1), Alzheimer (n: 1), Parkinson (n: 2) and using antihistamine (n: 1) were not included in the sample. Additionally, new patients were selected for the sample in place of patients (n: 4) who wished to withdraw from the study since they felt uncomfortable by the way the blanket was placed on them or were uncomfortable being uncovered above their wrists or ankles or lower than the bottom line of the clavicle, or who needed to remove the blanket completely because of the clinical interventions, or who had to be taken to the intensive care unit due to the unexpected changes in their general condition. Four different surgical teams and one single anesthesia team were performed the TKA surgeries in this hospital. The anesthesia team administered the same anesthetic medication as a spinal or local combined (spinal and epidural) to all patients in the sample.

Data Collection

The study was conducted between November 1, 2013, and May 1, 2014. To collect the data, a descriptive characteristics information form was used, which was developed in accordance with the literature. Tools included a tympanic thermometer

(Kendall), saturation measurement device (pulse oximeter) and sphygmomanometer (Omron). The researcher informed the nurses in the clinic about the procedures to be done for the experimental and control groups. The day before the application of this study, the researcher reviewed the list of the operations to be performed the next day and identified patients who would have TKA. The researcher also evaluated the fitness of these patients to sample criteria and patients were informed both verbally and in written form. After obtaining informed consent, it was measured patients' height and weight, recorded their demographic data, family history, medical history and the taking medication on a descriptive characteristics information form (DCIF) by the researcher. The researcher measured the patients' body temperatures in the same ear in which their body temperatures were measured when they had been hospitalized. The researcher evaluated whether there were earpieces, infections or external auditory canals for plugs in deciding in which ear to measure the body temperature. To measure the pulse, arterial blood pressure and SPO_2, it was used the arm that did not have established vascular access. It was obtained the temperature and humidity of the operating room one hour after each patient was taken to surgery and recorded this information on the DCIF.

In addition, a woolen blanket used in the clinic was laid on the bed while control group patients were in the operating room. For experimental group patients, an electric blanket was placed under the mattress and a wool blanket on the bed sheet while they were in the operating room. The electric blanket was operated at "warm" level for 20 minutes before the experimental patient left the operation room.

After the patients were taken to their own beds after surgery, the researcher covered them with a wool blanket from the top of clavicle to the bottom of their feet, put the sphygmomanometer on the arm without an IV line, positioned the sphygmomanometer so that the instrument panel was on the blanket and measured the patients' blood pressure. Then, the electric blanket was operated at the "warm" level for the experimental group, and it was turned off and unplugged when their body temperature reached 36,0 °C.

After each measuring of vital signs, it was recorded the responses "very little", "a little" and "very much" as "Yes", and the responses "no" and "no, I don't" as "No" by asking whether they felt cold or not. The researcher put the SPO_2 probe on the patients' fingers after blood pressure measurements and counted respiratory rates for one minute while waiting for the SPO_2 measurements. During the SPO_2 measurement, it was noted if patients did not move, did not have nail polish, henna or any other paint on their finger on which the measurement was made, whether the pigmentation of the skin was not different from other body sites, and whether the measurement site was not colder than other body sites. To prevent light in the room from affecting the measurement, the woolen blanket was placed on the patients' hands in a way so as not to prevent reading the measurement value after the saturation probe was placed on the finger. The patients' body temperatures were measured in the ear recorded on the DCIF. The ear was pulled back and entered at a right angle. After this measurement, the researcher evaluated shivering by observation, and recorded these data on the DCIF.

Finally, it was read the temperature and humidity in the room on a thermohygrometer and recorded the measurement on the evaluation form by the researcher. The researcher measured body temperature, pulse rate, respiration rate, arterial blood pressure, pulse pressure, oxygen saturation, feeling cold and shivering of experimental and control group before their surgeries, every 15 minutes after surgeries until being 36 ^{0}C of body temperature.

Ethical Considerations

This study was approved by a University's Clinical Research Ethics Committee in Ankara and, it was obtained permission by Public Hospitals Association General Secretariat. Informed consent was provided by all participants. All study procedures were

conducted in accordance with the Declaration of Helsinki.

Data Analysis

The descriptive statistics of the study are presented as means, standard deviations and frequency and percentages. The presence of a normal distribution was determined by the Kolmogorov-Smirnov test. Data was evaluated as using the chi-square test to compare categorical data in contingency tables, the Student's *t* test for normally distributed variables in comparing differences between the groups, the Mann-Whitney-U test for variables not normally distributed, one-way ANOVA for normally distributed variables in the comparison of more than two groups and Kruskal-Wallis analysis of variance when the variable was not normally distributed.

Limitations

The results of this study cannot be generalized because of the small sample size and the single research site. In addition, the results of this study might have been influenced by the temperatures of the rooms where the patients were monitored, the type of anesthesia administered to the patients and the team who performed the operation since these factors could not be controlled in the hospital where the study was conducted.

RESULTS AND DISCUSSION

Table 1 indicates that there was no significant difference between the patients in the experimental and control groups body mass index (BMI), chronic diseases, medication use, age or duration of stay at the hospital (p>0,05).

Table 1. Descriptive Characteristics of the Patients

Descriptive Characteristics		Control Group (n=23)		Experimental Group (n=23)		Statistical Analysis
		n	*%*	*n*	*%*	
Body mass index						
Normal		2	8,7	4	17,4	p=0,45
Overweight		6	26,1	8	34,8	
Obese		15	65,2	11	47,8	
Chronic Diseases						
Diabetes mellitus						
yes		5	21,73	5	21,73	p=1,00
no		18	78,27	18	78,27	
Hypertension						
Yes		17	73,91	13	56,5	p=0,21
No		6	26,09	10	43,5	
Medication Used						
Anti-hypertensive						
Yes		20	86,95	10	43,47	p=0,08
No		3	13,05	13	56,53	
Diuretic						
Yes		3	13,05	5	21,74	p=0,4
No		20	86,95	18	78,26	
Age[a]			68,09 ±5,169 (60-78 years)		69,00 ±4,815 (60-76 years)	p=0,53
Gender	**Female**		16		16	-
	60-69		9		9	-
	70-79		7		7	-
	male		7		7	-
	60-69		4		4	-
	70-79		3		3	-
Duration of Hospital Stay[a]			6,26 ±1,421 days (4-11 days)		6,18 ±1,593 days (4-9 days)	p=0,86

[a]: These values are means or standard deviations.

Table 2 reports that the difference between the experimental and control groups by duration of surgery, amount of fluids given to the patient during and after the surgery, the amount of fluid coming from the drain, temperature of the operating room, humidity of the operating room and humidity in the patient's room was not statistically significant (p>0,05). The wards where the patients in the experimental group were monitored were colder than the wards where the patients in the control group were monitored (p<0,05) because of seasonal changes which is a limitation to our study.

Table 2. Surgery and Operating Room Characteristics

The Characteristics of the Operations and Operation Rooms	Control Group (n=23)	Experimental Group (n=23)	Statistical Analysis
	X̄± SD	X̄± SD	
The length of the operation (minutes)	121,30 ±27,68	123,70 ±19,082	p=0,73
The amount of fluids given during the operation (ml)	1804,35 ±616,79	1821,74 ±568,056	p=0,92
The amount of fluids given after the operation (ml)	1393,48 ±955,87	1500,00 ±608,276	p=0,65
The amount of fluids coming from the drain (ml)	266,30 ±157,68	266,30 ±117,649	p=1,00
Temperature of the operation room	22,12 ±0,77	22,12 ±1,20	p=0,98
Humidity in the operation room	33,04 ±8,94	39,83 ±9,4	p=0,16
Temperature of the room where patients were monitored after the operation	25,53±2,92	23,61 ±1,60	**p=0,00**
Humidity of the room where patients were monitored after the operation	34,00 ±1,8	34,52 ±3,54	p=0,53
Type of anaesthesia administered to the patient (n, %)			
Spinal	7 (30.4)	(65.2)	**p=0,01**
Spinal and epidural	16 (69.6)	8(34.8)	

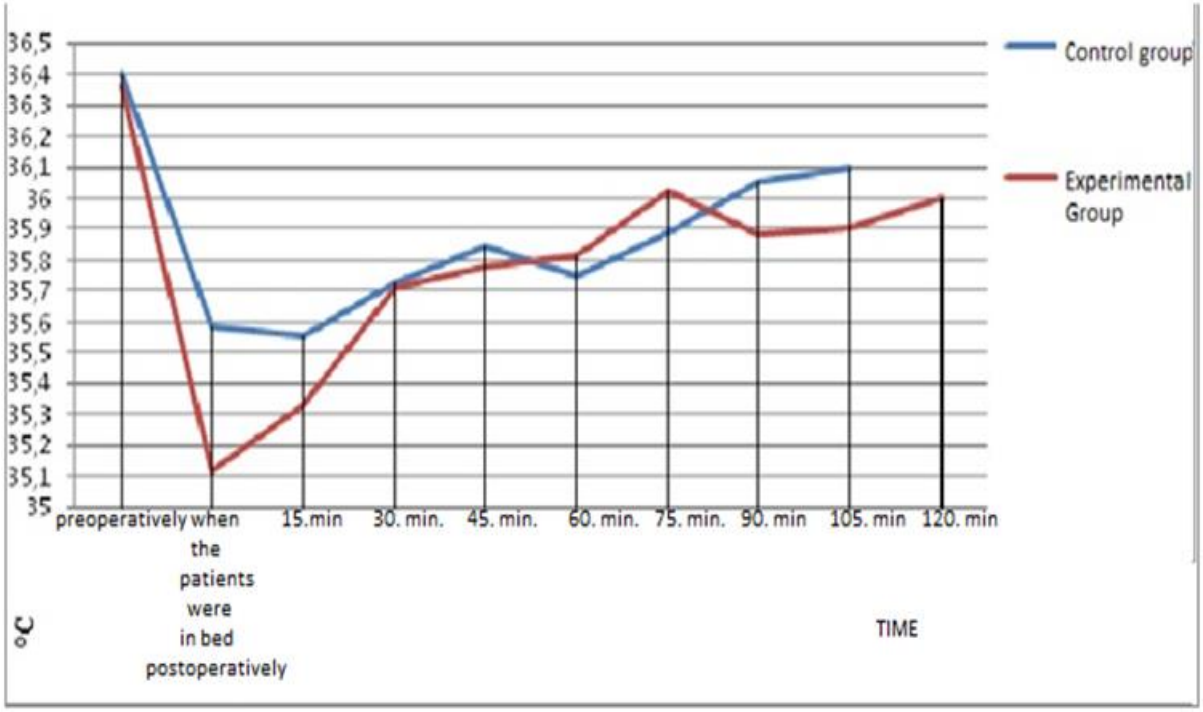
[a]: These values are numbers and percentages

Table 3 indicates that the difference between the experimental and control groups in the body temperature was not statistically significant except for a few timeframes (p>0,05). It was found that control group patients' body temperatures when they were taken to their rooms after the operation and in the first 15 minutes were significantly higher than those of the patients in the experimental group (p<0,05). The reason for their body temperatures being higher was that there were some significant differences between a few timeframes in the temperatures of the room where the patients were monitored after surgery and the types of anesthesia they had received. Meanwhile, it was found that the body temperatures of patients in the experimental group increased faster than those in the patients in the control group (Graphic 1). In addition, the number of the control group patients feeling cold was higher than those of the experimental group, however, the difference was not statistically significant (Table 3).

Although it is not shown in the table 3, the differences between vital values (pulse, arterial blood pressure and SPO_2 for each time) and shivering of the patients in the control and experimental group were not statistically significant (p>0,05).

Table 3. Body Temperature and Feeling of Cold in the Experimental and Control Groups by Timeframes

Body Temperature and Feeling Cold	Body Temperature (m ± sd)			Feeling of Cold (n, %)		
Timeframes	Control	Experimental	Statistical analysis	Control (Yes)	Experimental (Yes)	Statistical analysis
Preoperative	36,7±0,4	36,4±0,2	**P=0.00**	0 (0.0%)	0 (0.0%)	-
Being taken to the patient's bed after the operation	35,6±0,2	35,1±0,4	**P=0.00**	13 (56.5%)	7 (30,4%)	P=0.06
Postoperative: 15th minute	35,6±0,2	35,3±0,3	**P=0.01**	12 (52,1%)	9 (39,1%)	P=0.25
Postoperative: 30th minute	35,7±0,2	35,7±0,9	**P=0.93**	6 (26.0%)	3 (13,0)	P=0.32
Postoperative: 45th minute	35,8±0,2	35,8±0,3	p=0,47	5 (21.7%)	1 (4,3)	P=0.08
Postoperative: 60thminute	35,7±0,2	35,8±0,3	p=0,51	2 (8.7%)	0 (0.0%)	P=0.08
Postoperative: 75th minute	35,9±0,1	36,0±0,2	p=0.26	0 (0.0%)	0 (0.0%)	-
Postoperative: 90th minute	36,1±0,2	35,9±0,1	p=0.08	0 (0.0%)	0 (0.0%)	-
Postoperative: 105th minute	36,1±0,1	35,9±0,3	p=0.41	0 (0.0%)	0 (0.0%)	-
Postop: 120th minute	-	36,0±0,0	-	0 (0.0%)	0 (0.0%)	-



Graphic 1: Changes in Control and Experimental Group Body Temperatures in Time

DISCUSSION

Aging makes people more sensitive to hypothermia as a result of the slowing down of the thermoregulation mechanism.[28-30] For that reason, perioperative hypothermia, which is more frequent among the older people, is considered the most frequent and preventable complication in surgery.[31-33] In addition, the maintenance of normothermia is important for patient safety and satisfaction, positive surgical results, the maintenance of quality health care. As reported by Fred, Ford, 14 million people have hypothermia in the USA every year, and the prevalence of hypothermia in patients in intensive care units after surgery is between 30% and 40%.[34] In our study, although the hospital lengths of stay in the experimental group were shorter than those in the control group, the difference was not statistically significant (p>0,05) (Table 1). The length of stay of patients in the experimental and control groups were similar to those in other studies.[31-34]

The prevention of hypothermia in the perioperative period, which is common and can cause serious complications, is a subject that has been studied for the last two or three decades. Few studies on this subject report that passive heating methods can be used together with active heating methods.[35,36] In studies on blankets, it is seen that cotton blankets are used, but since cotton is a material with high heat permeability, it is reported that materials with low heat permeability should be preferred to prevent heat loss. Woolen blankets are known as the most effective covering tool against the cold and are used in hospitals in our country, but since we could not find any studies on wool blankets in the literature, we think that this study will contribute to the literature.[17,36] An analysis of table 3 indicated that the body temperatures of the control group patients rose faster than those of the experimental group patients until the 45th minute; body temperatures of control group patients were lower than those of the experimental group patients in the 60th and 75th minutes, and although the body temperatures of the control group patients were higher than those of the experimental group patients after the 90th minute, the difference between the two groups was mainly not statistically significant except for one or two timeframes ($p>0,05$). The reason for control group's body temperatures being higher until the 45th minute might be that temperature of the room where control patients were monitored after the operation was higher than those of experimental group (Table 2). As cited by Lundgren, Henriksson, Greif et al. conducted a laboratory study with real people, and after they repressed the shivering seen in moderate hypothermia, they heated one group of patients using carbon-fiber blankets which reflected heat and used passive heating methods for the other group.[37] At the end of the procedure, there was a slight decrease in the body temperatures of the patients who were heated using passive heating methods; however, the difference was not statistically significant and there was no decrease in the experimental group. Again, as cited by Lundgren, Henriksson, Kober et al. adapted this study by Greif et al. to trauma patients in the pre-hospital period and found that the body temperatures of the control group patients decreased by 0,4 °C/hour while that of the experimental group patients increased by 0,8 °C/hour ($p<0,05$).[37] The results of these studies are consistent with the results of our study. Graphic 1 shows that the body temperatures of experimental group patients increased faster than those of the control group patients. Since the decreases in the patients' body temperatures continued until the effects of the anesthetic medication disappeared, central body temperature could increase by 0,5 º C/hour when active or passive heating methods were not applied.[34] The body temperatures of the control group patients increased by 0,16 º C in the 60th minute while those of the experimental group patients increased by 0,70 ºC in the 60th minute. Thus, a woolen blanket which was at the room temperature could not increase the body temperature. However, an electric blanket together with a woolen blanket increased the body temperature.

The number of the control group patients feeling cold was higher than those of the experimental group (Table 3). The change in the rate of patients who felt cold indicated that the thermal comfort of the patients who used an electric blanket together with a woolen blanket was better than that of the patients who used only a woolen blanket. Winslow, Susan conducted a study and compared the body temperatures of the patients who had large-scale surgeries measured with three different thermometers after anesthesia in the intensive care unit and reported that 32,8% of the patients felt cold.[38] According to the study by Jardeleza, Fleig, 9% of the control group and 8% of the experimental group felt cold, and the difference between the two groups was statistically insignificant. In this study, of the patients in the control group, the number of those who felt cold was higher than the numbers reported in the study of Jardeleza et al.[39]

It was found that the numbers of experimental and control group patients who shivered were similar in this study. Shivering that can be seen with feeling cold increases the

consumption of oxygen, and the production of lactic acid and carbon dioxide. This causes serious problems particularly in the elderly with the cardiopulmonary disease since it accelerates metabolism and puts more pressure on the heart. When thermoregulation slows down in the elderly, the shivering response decreases and causes hypothermia to last longer.[40] Horn et. al. conducted a study with 62 women who had a caesarean section, and reported that the use of heater fans together with cotton blankets did not make a significant difference in the mean body temperature and the prevalence of shivering.[40] Although at first glance, cesarean section and orthopedic surgery may seem like different fields, the cesarean section and TKA incision are almost similar in size. The depth of the tissues cut in TKA surgeries is slightly greater than in cesarean section. In terms of duration, both processes end in almost the same time. Both procedures can be performed under both epidural anesthesia and general anesthesia. For these reasons, it was thought that our study could be compared with Horn et al.'s study, since cesarean section and arthroplasty are similar conditions in terms of thermoregulation.

CONCLUSION AND SUGGESTIONS

Although the difference between the vital signs and feeling cold and shivering of the control group patients and experimental group patients was mainly not statistically significant except for few timeframes, especially, the body temperatures of patients in the experimental group increased faster than those in the patients in the control group. It can be concluded that this resulted from the use of a woolen blanket together with an electric blanket, which increased body temperature.

This study provides an evidence whether or not woollen blanket as a passive heating technique have any effect on hypothermia. Using a woollen blanket together with an electric blanket might help to manage hypothermia control rather than using cotton blankets alone. In future studies, researchers could study with a younger population, different types of anesthesia and surgeries.

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