

The effects of active warming on perioperative inadvertent hypothermia in patients undergoing vitreoretinal surgery under local anesthesia

Aykut Urfalioglu, Selma Urfalioglu¹, Gozen Oksuz, Adem Doganer², Seyma Teksen⁴, Ozlem Guler³, Feyza Calisir

Purpose: Perioperative inadvertent hypothermia (PIH) is the decrease in core temperature below 36°C. We aimed to assess whether PIH develops in patients operated under local anesthesia (ULA) for vitreoretinal surgery in the operating room and investigate active warming efficacy. **Methods:** Seventy-two patients were divided into two groups: Group 1 contained unwarmed patients ($n = 36$), and Group 2, warmed patients ($n = 36$). The core temperatures, heart rate (HR), and mean arterial pressure (MAP) of the patients were measured at the beginning of surgery, after 20 min, 40 min, 1 h, at the end of the operation, and during the postoperative period. **Results:** PIH incidence was 44.6% in Group 1, whereas no hypothermia was observed in Group 2. Patient temperatures at 20 min ($P = 0.001$), 40 min ($P < 0.001$), 1 h ($P < 0.001$), the end of the operation ($P < 0.001$), and the postoperative period ($P < 0.001$) were significantly higher in Group 2 than in Group 1. Patient HRs at the end of the operation and during the postoperative period were significantly lower in Group 2 ($P = 0.005$) than in Group 1 ($P < 0.001$). The intraoperative 40th ($P = 0.044$) and 60th ($P < 0.001$) minutes, end of operation ($P < 0.001$), and postoperative MAP ($P < 0.001$) values of Group 1 were significantly higher than those of Group 2. **Conclusion:** PIH may develop in patients operated ULA, especially with a low ambient temperature. Actively warming may help prevent the harmful effects of PIH.

Key words: Body temperature, hypothermia, local anesthesia, vitreoretinal surgery, warming

Perioperative inadvertent hypothermia (PIH) is defined as the decrease in core temperature below 36°C starting 1 h before the operation and continuing into the postoperative period.^[1,2] The incidence varies between 11% and 90% depending on the type of surgery conducted and anesthesia administered.^[3,4] The risk increases in patients with an American Society of Anesthesiologists (ASA) risk score of >1, an age of ≥60 years, a low body mass index (BMI); those who receive a combination of general and regional anesthesia; and those who undergo moderate or major surgery.^[5,6] PIH has also been shown to alter intraoperative drug effects, increase bleeding and delay the recovery time, increase cardiac side effects, and increase infection rates.^[7,8]

During hypothermia, the hypothalamus, which controls thermoregulation, maintains a constant core temperature of 37°C ± 0.2°C via mechanisms including vasoconstriction and shivering. However, anesthetic agents prevent these mechanisms by suppressing hypothalamic function, which causes the core temperature to fall. Moreover, general anesthetics may cause vasodilation, whereas regional anesthetics produce sympathetic nerve block; these mechanisms may further exacerbate hypothermia.^[9,10] The rapid heat loss (~0.5°C–1.5°C) during the first 30 min of the perioperative period is followed

by slower heat loss. After 4 h, core temperature is subsequently stabilized between 33°C and 35°C because of vasoconstriction and shivering activated by the elimination of hypothalamic inhibition.^[8]

Another factor that causes PIH is low operating room temperature. Despite several published guidelines recommending the operating room be kept between 21°C and 22°C, noticeable heat transfer occurs from the warm surface of the body to the cold walls through radiation.^[5,10,11] Heat loss also occurs through internal airflow (convection), direct contact with the cold operating table (conduction), and evaporation.^[5] Although general and regional anesthesia methods are known to cause hypothermia, PIH is less expected to develop because of the preservation of hypothalamic mechanisms in procedures conducted under local anesthesia (ULA). However, a cold operating room may cause heat loss via these four mechanisms and cause PIH in elderly patients with comorbid diseases.^[12,13]

Warming patients during the perioperative period is emphasized to prevent the complications of hypothermia. For this purpose, active heating methods including forced-air warming (FAW), using electric blankets and radiant heaters, are preferable to passive heating using blankets and drapes.^[2,5,12,14,15]

Departments of Anesthesiology and Reanimation, ¹Ophthalmology, ²Biostatistics and Medical Informatics and ³Emergency Medicine, Kahramanmaras Sutcu Imam University, Faculty of Medicine, ⁴Department of Anesthesiology and Reanimation, Afşin State Hospital, Kahramanmaras, Turkey

Correspondence to: Dr. Aykut Urfalioglu, Department of Anesthesiology and Reanimation, Kahramanmaras Sutcu Imam University, Faculty of Medicine, Avsar Campus, 46100, Onikisubat, Kahramanmaras, Turkey. E-mail: aykutmd1903@gmail.com

Received: 02-Feb-2020

Revision: 19-May-2020

Accepted: 12-Jul-2020

Published: 18-Jan-2021

Access this article online

Website:

www.ijo.in

DOI:

10.4103/ijo.IJO_227_20

Quick Response Code:



This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Cite this article as: Urfalioglu A, Urfalioglu S, Oksuz G, Doganer A, Teksen S, Guler O, *et al.* The effects of active warming on perioperative inadvertent hypothermia in patients undergoing vitreoretinal surgery under local anesthesia. *Indian J Ophthalmol* 2021;69:308-13.

We aimed to investigate whether PIH primarily develops in patients undergoing vitreoretinal surgery ULA in the operating room. We also aimed to determine whether active warming starting from the preoperative period prevents the development of PIH and identify its effects on hemodynamic parameters.

Methods

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Approval for this study was granted by the Clinical Research Ethics Committee of the Kahramanmaraş Sutcu Imam University Faculty of Medicine (approval number/date: 108/07-2017).

The present study had a prospective, randomized design. The study was started after patients received a verbal description of the procedures to be performed. Written consent was obtained from patients who fulfilled the following criteria: ≥ 40 years of age, an ASA score of II–III, and were undergoing classical three or four port pars plana vitreoretinal surgery ULA with an expected operative time of ≥ 1 h. The exclusion criteria were determined as follows: central nervous system disease, a preoperative a core temperature of $<36^{\circ}\text{C}$ or $>37^{\circ}\text{C}$, conditions that may cause errors in temperature measurement (ear shape abnormality, infection, etc.), patient non-compliance with a lack of established verbal cooperation, operative time of <1 h, need for additional local anesthesia due to pain and continuing the operation under general anesthesia after starting ULA. For preoperative premedication, Xanax 0.5 mg orally (Alprazolam tb, Pfizer, USA) were administered to all subjects.

The power analysis was conducted using R.3.3.2. software per the methods described by Andrzejowski *et al.*^[16] Type I error (α) was set at 0.05, and type II error (β), at 0.20, whereas the power was set at 0.80 for the calculation.

Based on this analysis, a total of 72 patients ($n = 36$ per group) were included in the study considering the differences between the p_1 and p_2 ratios ($0.68 - 0.43 = 0.25$). Patients were randomly assigned to one of the two groups after pulling two different colored balls from a bag: Group 1 ($n = 36$) included the unwarmed patients, and Group 2 ($n = 36$), the warmed patients. In this study, hypothermia was defined as a core temperature of $<36^{\circ}\text{C}$.

Patients in Group 1 were only draped passively, whereas those in Group 2 were warmed with FAW device [3M™ Bair Hugger™ Warming Unit-Model 775 (3M Health Care, USA)] until they were transferred to the operating room and subsequently draped [Fig. 1]. The patients were transferred to the operating room at the end of 20 min.

The temperature of the operating room was kept constant at 22°C throughout the procedure using a calorimetric adjustment system. Patients were routinely monitored (Dräger Infinity Kappa monitor-Dräger Medical GmbH, Germany), and the following measurements were obtained: core temperature, heart rate (HR), and mean arterial pressure (MAP). After the sterilization procedures were conducted by an ophthalmologist, the patients in Group 1 were draped with a normal cloth, whereas those in Group 2 received active warming at 40°C until the end



Figure 1: Active warming method applied to patients by forced-air warming (FAW) device

of the operation. For the local anesthesia, a total of 4 ml mixture containing 2 ml lidocaine HCl (Jetocaine Simplex 2% amp., Adeka, TURKEY) and 2 ml bupivacaine HCl (Marcaine 0.5% flk., AstraZeneca, UK) were administered in equal amounts as retrobulbar and peribulber block. The core temperatures were measured at the beginning of the operation, after 20 min, after 40 min, after 1 h, and at the end of the operation. Core temperatures were non-invasively measured using an infrared tympanic digital thermometer (Riester ri-thermo®N, Rudolf Riester GmbH & Co. KG, Germany). This measurement was repeated twice at 5–10 s intervals, and the lower value was recorded.

The patients who were transferred to the recovery room after the operation were kept there for 20 min. The temperature of the recovery room was at 24°C – 25°C (normal room temperature) throughout the study. During that time, their postoperative shivering scores and core temperatures were evaluated. The following system was used to classify postoperative shivering: 0 = no shivering, 1 = only the presence of piloerection with peripheral vasoconstriction, 2 = muscular activity affecting only one muscle group, 3 = muscular activity involving more than one muscle group but without generalized shivering, and 4 = diffuse muscular activity involving the entire body.^[17]

Statistical analysis

SPSS v. 22.0 software package (IBM Corporation, Armonk, New York, United States) was used for the statistical analysis. The normality of the data was tested by the Shapiro–Wilk test. In normally distributed variables, the difference between the

groups in terms of quantitative variables was evaluated by the independent samples *t*-test, while the difference between repeated measures was evaluated by the repeated measured ANOVA test. The Bonferroni test was used for the post-hoc analysis. The correlations between the variables was analyzed by the Pearson correlation test, and the Chi-square test was used to determine the frequency distributions between the categorical data. The level of significance was set at $P < 0.05$.

Results

When 72 patients included in the study were analyzed in terms of demographic data, the mean age was 62.7 ± 11.7 years in group 1, and 63.9 ± 9.1 years in group 2; the mean body mass index (BMI) was 29.2 ± 3.4 kg/m² in group 1 and 28.9 ± 3.0 kg/m² in group 2, and there was no significant difference between the groups in terms of both data ($P = 0.231$, $P = 0.499$; respectively). Moreover, the data obtained when the mean age values of the patients were categorized as <60 , ≥ 60 and BMI values as <25 , $25-30$, $30-40$ are given in Table 1 along with other demographic data. Similarly, there was no significant difference between the groups when the mean duration of surgery of the patients were analyzed (69.97 ± 7.44 min, 68.81 ± 6.96 min, respectively) ($P = 0.494$). While 14 of the patients in Group 1 had diabetes mellitus (DM), one had hypertension (HT) and one had coronary artery disease (CAD); In Group 2, 18 patients had DM, four had HT, and two had CAD.

When the perioperative HR values were evaluated, the end of operation HR (79.78 ± 12.68 bpm) and postoperative HR (77.50 ± 10.70 bpm) values of the warmed patients in group 2 were significantly lower than the end of operation HR (87.36 ± 9.01 bpm) and postoperative HR (90.64 ± 9.49 bpm) values of the non-warmed patients in group 1 ($P = 0.005$, $P < 0.001$, respectively). In the within-group comparison of the data, the preoperative HR values in group 1 were significantly lower than all other time values, while the end of operation and postoperative HR values were significantly higher than the intra-operative 20th, 40th, 60th min HR values ($P < 0.001$). The HR values of group 2 were similar in all patients in the same group at all determined times ($P = 0.139$) [Table 2].

Table 1: Demographics data of the patients

	Group				P
	Group 1		Group 2		
	n	%	n	%	
Gender					
Female	20	55.6	22	61.1	0.229
Male	16	44.4	14	38.9	
Age (y)					
<60	12	33.3	7	20.6	0.231
≥ 60	24	66.7	27	79.4	
BMI (kg/m ²)					
<25	4	11.1	3	8.3	0.499
25-30	16	44.4	21	58.3	
30-40	16	44.4	12	33.3	

Chi-Square test; $\alpha = 0.05$. Data are expressed as number of the patients (n) %; $P < 0.05$ is statistically significant; Group 1: The unwarmed patients, Group 2: The warmed patients; BMI: Body mass index

When the peri-operative MAP values of the patients were analyzed between the groups, the intra-operative 40th min (111.67 ± 13.30 mmHg), intra-operative 60th min (111.75 ± 12.70 mmHg), end of operation (115.08 ± 10.90 mmHg), and postoperative MAP values (115.44 ± 11.20 mmHg) of group 1 were significantly higher than the intra-operative 40th minute (105.39 ± 12.70 mmHg), intra-operative 60th min (98.64 ± 12.32 mmHg), end of operation (94.64 ± 11.97 mmHg), and postoperative MAP values (93.17 ± 9.64 mmHg) of group 2 ($P = 0.044$, $P < 0.001$, $P < 0.001$, $P < 0.001$, respectively). When the intra-group analyzes of MAP values in both groups were performed, the preoperative MAP values in group 1 were found to be significantly lower than all other time values ($P = 0.001$) In group 2, the values of start operation, end operation, and postoperative MAP were significantly different from the preoperative MAP value ($P < 0.001$) [Table 3].

When the body core temperatures of the patients were evaluated, it was found that the incidence of perioperative hypothermia was 44.6% in group 1, whereas no hypothermia was observed in group 2. The preoperative and start of operation values ($P = 0.929$, $P = 0.054$) were similar between the two groups, while there were significant differences in all other time periods. The temperature values were significantly higher in group 2 than in group 1 ($P = 0.001$, $P < 0.001$, $P < 0.001$, $P < 0.001$, $P < 0.001$, respectively). When the patients in the same group were compared according to times, it was found that the intra-operative 40th minute, intra-operative 60th min, end of operation and postoperative temperature values of the patients in group 1 decreased proportionally over time compared to the preoperative temperature value. Whereas in group 2, it was found that the preoperative temperature values were significantly lower than all other time periods and the temperature values increased over time [Table 4].

The peri-operative changes in the HR, MAP, and body core temperatures of the warmed and unwarmed patients are shown in Fig. 2a-c.

When the postoperative shivering scores were evaluated, no patient with a shivering score above 2 was detected in both groups. The number of patients with no shivering (score 0) was 28 (77.8%) in group 1 and 35 (97.2%) in group 2, while the number of patients with a shivering score of 1 was 7 (19.4%) in group 1 and 1 (2.8%) in group 2. There was no patient with a shivering score of 2 in group 2, while the number of patients with a shivering score of 2 was 1 (2.8%) in group 1. In conclusion, the post-operative shivering score was significantly lower in the warmed patients in group 2 than in group 1 ($P = 0.043$).

Discussion

Previous studies have focused on general and/or regional anesthesia, which have known mechanisms of inducing PIH. This study is the first to investigate whether actively warming the operating room environment and the patients prevents PIH during vitreoretinal surgeries conducted ULA. It was demonstrated that actively warming these patients prevented hypothermia and had positive effects on hemodynamic parameters and postoperative shivering scores.

Among awake patients who only receive an intraocular local anesthetic, PIH could develop because of the cold environment without affecting the central thermoregulatory mechanism.

Table 2: Heart rate values of the patients in the peri-operative period

Group	pre-op HR (bpm)		Start of operation HR (bpm)		Intra-op 20' HR (bpm)		Intra-op 40' HR (bpm)		Intra-op 60' HR (bpm)		End of operation HR (bpm)		Post-op HR (bpm)		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Group 1	76.14	^{b-g} 12.38	82.08	^{a,e,f} 11.26	81.11	^{a,e,f} 11.23	83.36	^{a,e,f} 12.31	83.89	^{a,e,f} 10.88	87.36	^{a-f} 9.01	90.64	^{a-f} 9.49	<0.001*
Group 2	77.92	10.61	82.42	13.12	81.47	12.96	80.89	14.32	80.25	11.61	79.78	12.68	77.50	10.70	0.139
P	0.515		0.908		0.900		0.435		0.174		0.005**		<0.001**		

Data are mean-SD (standart deviation); $P < 0.05$ is statistically significant; Independent samples *t*-test; Repeated Measured ANOVA test; *Post-hoc*: Bonferroni test; $\alpha = 0.05$. Bold: *The difference between repeated measurements are statistically significant; **The difference between the unwarmed (Group 1) and the warmed (Group 2) patients are statistically significant. ^aThe difference between preoperative measurements is significant; ^bThe difference between start of operation measurements is significant; ^cThe difference between intraoperative 20th min measurements is significant; ^dThe difference between intraoperative 40th min measurement is significant; ^eThe difference between intraoperative 60th min measurements is significant; ^fThe difference between end of operation measurements is significant; ^gThe difference between postoperative measurements is significant

Table 3: Mean arterial pressure values of the patients in the peri-operative period

Group	Pre-op MAP (mmHg)		Start of operation MAP (mmHg)		Intra-op 20' MAP (mmHg)		Intra-op 40' MAP (mmHg)		Intra-op 60' MAP (mmHg)		End of operation MAP (mmHg)		Post-op MAP (mmHg)		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Group 1	99.75	^{b-g} 17.55	112.56	^a 14.43	111.53	^a 13.16	111.67	^a 13.30	111.75	^a 12.70	115.08	^a 10.90	115.44	^a 11.20	0.001*
Group 2	103.36	^{b,f,g} 18.58	110.42	^{a,e,f,g} 17.88	107.92	^{e,f,g} 13.53	105.39	^{e,f,g} 12.70	98.64	^{b-g} 12.32	94.64	^{a-e} 11.97	93.17	^{a-e} 9.64	<0.001*
P	0.399		0.578		0.255		0.044**		<0.001**		<0.001**		<0.001**		

Data are mean-SD (standart deviation); $P < 0.05$ is statistically significant; Independent samples *t* test; Repeated Measured ANOVA test; *Post-hoc*: Bonferroni test; $\alpha = 0.05$. Bold: *The difference between repeated measurements are statistically significant; **The difference between the unwarmed (Group 1) and the warmed (Group 2) patients are statistically significant. ^aThe difference between preoperative measurements is significant; ^bThe difference between start of operation measurements is significant; ^cThe difference between intraoperative 20th min measurements is significant; ^dThe difference between intraoperative 40th min measurement is significant; ^eThe difference between intraoperative 60th min measurements is significant; ^fThe difference between end of operation measurements is significant; ^gThe difference between postoperative measurements is significant

Table 4: Body core temperature values of the patients in the peri-operative period

Group	Pre-op Temperature (°C)		Start of operation Temperature (°C)		Intra-op 20' Temperature (°C)		Intra-op 40' Temperature (°C)		Intra-op 60' Temperature (°C)		End of operation Temperature (°C)		Post-op temperature (°C)		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Group 1	36.5	^{d-g} 0.3	36.4	^{d-g} 0.3	36.4	^{f,g} 0.3	36.3	^{a,b,f,g} 0.3	36.3	^{a,b,f,g} 0.3	35.9	^{a-e,g} 0.2	36.0	^{a-f} 0.2	<0.001*
Group 2	36.4	^{b-g} 0.3	36.5	^{a,g} 0.2	36.6	^a 0.2	36.7	^{a,g} 0.2	36.6	^a 0.2	36.6	^a 0.2	36.6	^{a,b,d} 0.2	<0.001*
P	0.929		0.054		0.001**		<0.001**		<0.001**		<0.001**		<0.001**		

Data are mean-SD (standart deviation); $P < 0.05$ is statistically significant; Independent samples *t* test; Repeated Measured Anova test; *Post-hoc*: Bonferroni test; $\alpha = 0.05$. Bold: *The difference between repeated measurements are statistically significant; **The difference between the unwarmed (Group 1) and the warmed (Group 2) patients are statistically significant. ^aThe difference between preoperative measurements is significant; ^bThe difference between start of operation measurements is significant; ^cThe difference between intraoperative 20th min measurements is significant; ^dThe difference between intraoperative 40th min measurement is significant; ^eThe difference between intraoperative 60th min measurements is significant; ^fThe difference between end of operation measurements is significant; ^gThe difference between postoperative measurements is significant

However, the active warming technique starting from during the preoperative period prevented the development of PIH and improved hemodynamic parameters.

The literature shows that serious complications mostly associated with mild hypothermia (35.5°C–35.9°C), rather than moderate (35.0°C–35.4°C) and severe hypothermia (<35°C), develop during the perioperative period.^[7,18] PIH results in a bad experience for patients; in fact, they tend to focus on the chill and shivering rather than postoperative pain.^[9] These complications and high levels of patient discomfort

caused anesthetists and surgical clinics to focus more on this issue. Within the last 20–30 years, guidelines on the management and prevention of PIH have been published in many countries. These guidelines and studies have largely focused on identifying conditions that increase the risk of PIH before complications occur.^[2,5,11,12] Experts agree that the risk of developing PIH increases with advanced age, low BMI, comorbid disease, an ASA risk score of >I, and prolonged major operations that require general and/or regional anesthesia.^[3,19,20] We largely encountered similar factors in this study; however, we administered local anesthesia rather than general and/or

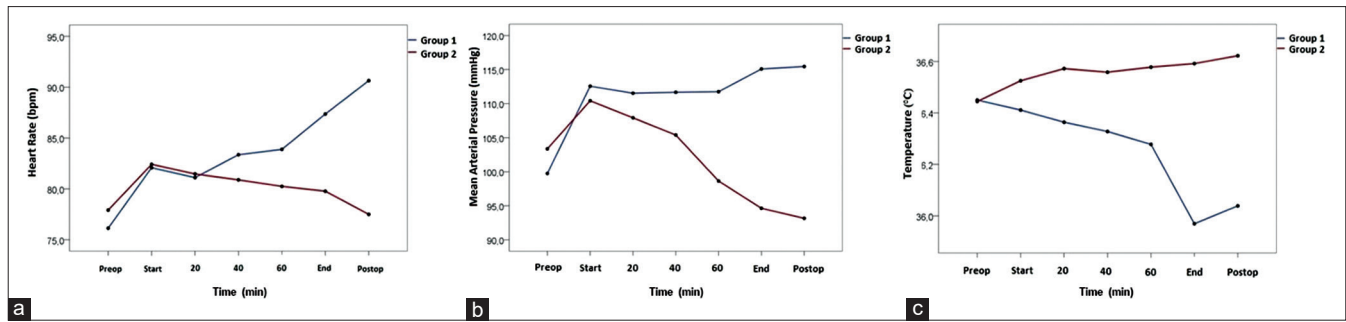


Figure 2: Peri-operative changes in heart rate (a), mean arterial pressure (b) and core temperature (c) in patients who received forced air warming or not during vitreoretinal surgery

regional anesthesia. Furthermore, patients with low BMI values were not included in this study. When the BMI values were grouped, the number of patients with a BMI <25 was very low in both groups. By contrast, the number of patients with an ASA risk of II and III due to comorbidities was high among both groups. Moreover, most of these patients aged ≥ 60 years, but this is not unusual among patients undergoing ocular surgery. Additionally, the operative time of >1 h in both groups is an acceptable risk factor.

In patients receiving general and regional anesthesia, the thresholds for vasoconstriction and shivering increase with hypothalamic inhibition. These two mechanisms, which are activated within a narrow threshold range in normal individuals, cannot be activated simultaneously. Therefore, hypothermia occurs because heat loss cannot be prevented. Moreover, vasodilation caused by general anesthetics and sympathetic block induced by regional anesthesia further exacerbates hypothermia.^[8,9] Hence, almost all studies regarding the management and prevention of PIH have been conducted on patients receiving general or regional anesthesia. According to our literature review, only one study investigated the incidence of PIH and the effect of warming among patients who only received IV sedation based on the German S3 guideline.^[5] This study reported that perioperative warming was effective in preventing PIH; however, sedation only comprised a small portion of all anesthesia techniques, and direct PIH rates were not given.^[21] Conway *et al.*^[22] reported a hypothermia rate of 23.3% among patients undergoing sedation in the cardiac catheterization laboratory. This rate was very high considering that that general anesthesia was not used, and the procedure was performed outside the operating room. Our study, which investigated patients undergoing vitreoretinal surgery ULA in a cold operating room environment, is designed differently in this sense. We predicted that patients who were transferred to the operating room with a thin cloth and remained in this cold environment could also develop PIH because of environmental factors rather than anesthetic effects. It was observed that almost half of the patients using passive warming techniques developed mild PIH from the time they were transferred to the operating room to the postoperative period. By contrast, patients who were actively warmed up with FAW did not develop hypothermia at all. Similarly, the postoperative shivering scores were higher among unwarmed patients. These results may suggest that patients operated ULA may develop hypothermia through radiation, convection, conduction, and evaporation because of cold

ambient temperature. As is seen in the study, active warming starting from the preoperative period and continuing during and after the operation effectively prevented PIH and postoperative shivering.

In many studies focusing on how and during which perioperative stage the patients should be warmed, active heating starting before the operation and continuing during the intraoperative period was highly effective in preventing PIH.^[23,24] German anesthesiologists recommend that patients be warmed up for 20–30 min before surgery,^[5] whereas the British NICE guidelines recommend actively warming all patients with a preoperative core temperature of <36°C. These guidelines also indicate that active warming is important for patients with PIH-related risk factors and/or for all operations lasting >30 min.^[2] In line with these recommendations, similar procedures were performed in our study, and positive results were obtained by actively warming the patients.

It has been reported that cardiac complications observed during even mild cases of PIH may occur during the intraoperative and postoperative periods because of shivering. Excess oxygen consumption due to shivering can trigger myocardial ischemia.^[7] Here, the reactivation of the peripheral vasoconstriction mechanism and the increase in norepinephrine levels have been held responsible for adverse cardiac effects.^[10] Based on this information, it can be stated that the high rates of tachycardia and hypertension among unwarmed patients at the end of the operation and during the postoperative period show the benefits of perioperative warming. Therefore, it can be predicted that the active warming of patients may prevent cardiac complications, including those undergoing ocular surgeries ULA.

The present study has two limitations. This study was limited to a single hospital, and other centers were not included. However, the absence of FAW devices in many hospitals currently and/or the inability to keep operating room temperatures constant at 21°C–22°C could affect the level of standardization required to conduct a multicenter study. The second limitation relates to the psycho-hemodynamic interactions brought by patients' conscious states since no anesthetic agent was used. However, it was observed that these effects can be minimized by explaining the methods in detail to all participants before the study and stating that they can leave the study if they wish. In addition, it was observed that the administration of preoperative anxiolytic to all patients relieved the patients quite psychologically.

Conclusion

PIH may develop in patients operated ULA because of the effect of low ambient temperature. It was demonstrated that actively warming these patients starting from the preoperative period until they were transferred to the ward prevented hypothermia and had positive effects on hemodynamic parameters.

Ethics committee approval

The study was approved by the Clinical Research Ethics Committee of the Kahramanmaraş Sutcu Imam University Faculty of Medicine (approval number/date: 108/07-2017).

Acknowledgements

We would like to thank Assoc. Prof. Mete Guler for her help in the writing and revision stages of the publication.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest

References

- Sajid MS, Shakir AJ, Khatri K, Baig MK. The role of perioperative warming in surgery: A systematic review. *Sao Paulo Med J* 2009;127:231-7.
- National Collaborating Centre for Nursing and Supportive Care (UK). The Management of Inadvertent Perioperative Hypothermia in Adults [Internet]. London: Royal College of Nursing (UK); 2008 Apr. (NICE Clinical Guidelines, No. 65.). Available from: <https://www.nice.org.uk/guidance/cg65>. [Last updated on 2016 Dec 14].
- Sholten R, Leijten B, Kremers K, Snoeck M, Koëter S. The incidence of mild hypothermia after total knee or hip arthroplasty: A study of 2600 patients. *J Orthop* 2018;15:408-11.
- Moola S, Lockwood C. Effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment. *Int J Evid Based Healthc* 2011;9:337-45.
- Torossian A, Bräuer A, Höcker J, Bein B, Wulf H, Horn EP. Preventing inadvertent perioperative hypothermia. *Dtsch Arztebl Int* 2015;112:166-72.
- John M, Harper M. Inadvertent peri-operative hypothermia: Guidance and protecting patients. *Br J Healthcare Manage* 2014;20:206-11.
- Sessler DI. Complications and treatment of mild hypothermia. *Anesthesiology* 2001;95:531-43.
- Díaz M, Becker DE. Thermoregulation: Physiological and clinical considerations during sedation and general anesthesia. *Anesth Prog* 2010;57:25-32; quiz 33-4.
- Sessler DI. Perioperative thermoregulation and heat balance. *Lancet* 2016;387:2655-64.
- Bayter-Marín JE, Rubio J, Valedón A, Macías ÁA. Hypothermia in elective surgery: The hidden enemy. *Rev Colomb Anestesiol* 2017;45:48-53.
- Turkish Society of Anaesthesiology and Reanimation practice guideline for prevention of unintentional perioperative hypothermia. *Turk J Anaesthesiol Reanim* 2013;41:188-90.
- Bashaw MA. Guideline implementation: Preventing Hypothermia. *AORN J* 2016;103:305-10; quiz 311-3.
- Healy K, O'Sullivan A, McCarthy L. A nurse-led audit on the incidence and management of inadvertent hypothermia in an operating theatre department of an Irish hospital. *J Perioper Pract* 2019;29:54-60.
- Duff J, Walker K, Edward KL, Ralph N, Giandinoto JA, Alexander K, *et al.* Effect of a thermal care bundle on the prevention, detection and treatment of perioperative inadvertent hypothermia. *J Clin Nurs* 2018;27:1239-49.
- Bilgin H. Inadvertent perioperative hypothermia. *Turk J Anaesthesiol Reanim* 2017;45:124-6.
- Andrzejowski J, Hoyle J, Eapen G, Turnbull D. Effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anaesthesia. *Br J Anaesth* 2008;101:627-31.
- Zhang R, Chen X, Xiao Y. The effects of a forced-air warming system plus electric blanket for elderly patients undergoing transurethral resection of the prostate: A randomized controlled trial. *Medicine (Baltimore)* 2018;97:e13119.
- Jo YY, Chang YJ, Kim YB, Lee S, Kwak HJ. Effect of preoperative forced-air warming on hypothermia in elderly patients undergoing transurethral resection of the prostate. *Urol J* 2015;12:2366-70.
- Akers JL, Dupnick AC, Hillman EL, Bauer AG, Kinker LM, Hagedorn Wonder A. Inadvertent perioperative hypothermia risks and postoperative complications: A retrospective study. *AORN J* 2019;109:741-7.
- Billeter AT, Hohmann SF, Druen D, Cannon R, Polk HC Jr. Unintentional perioperative hypothermia is associated with severe complications and high mortality in elective operations. *Surgery* 2014;156:1245-52.
- Gabriel P, Höcker J, Steinfath M, Kutschick KR, Lubinska J, Horn EP. Prevention of inadvertent perioperative hypothermia-Guideline compliance in German hospitals. *Ger Med Sci* 2019;17:Doc07.
- Conway A, Kennedy W, Sutherland J. Inadvertent hypothermia after procedural sedation and analgesia in a cardiac catheterization laboratory: A prospective observational study. *J Cardiothorac Vasc Anesth* 2015;29:1285-90.
- Maleki A, Soltani AE, Goudarzi M, Esbahbodi E, Takraze A, Taghi Zadeh 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;16:48-54.
- Lau A, Lowlaavar N, Cooke EM, West N, German A, Morse DJ, *et al.* Effect of preoperative warming on intraoperative hypothermia: A randomized-controlled trial. *Can J Anaesth* 2018;65:1029-40.