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Warming patients during spinal surgery

Birgül Bağatur[1], Arzu Tuna[2], Necati Üçler[3]

[1]İzmir Tınaztepe University Faculty of Health Science, Deparment of Nursing, İzmir, Türkiye
[2]Balıkesir University Faculty of Health Sciences, Department of Nursing, Balıkesir, Türkiye
[3]Gaziantep University Faculty of Medicine, Department of Neurosurgery, Gaziantep, Türkiye

ABSTRACT

Objective: The effect of active heating on the post-overative physiological parameters of patients who were operated on in the prone position and underwent laminectomy due to single-level lumbar stenosis was investigated.

Materials and Methods: The study was evaluated with 60 patients in the operating room environment between March 1, 2022, and September 1, 2022. The experimental group was heated with a blanket; the control group was heated with a blown air system. Vital signs and laboratory values of all patients were evaluated before, during, immediately after, 8 and 24 hours after surgery. Immediately after anesthesia was given, the patients' physiological changes/laboratory findings during the surgery, antibiotic monitoring schedule, and post-operative patient's physiological changes/laboratory findings recording data were evaluated.

Results: The patients received warmth from heated blankets in the recovery room both before and after the surgical procedure, while electrical devices were used for heating during the operation. Comparable outcomes were observed in the measurements of blood pressure, pulse, respiratory rate, and body temperature among the patients. Additionally, the blood test results for all patients showed similarities.

Conclusion: Both methods we used in our study were effective in preventing hypothermia. The physiological parameters of patients subjected to the two different warming techniques during surgery showed no significant difference (p>0.05).

Keywords: Nursing, surgery, warming, hypothermia

INTRODUCTION

Warming patients during surgery is a critical aspect of perioperative care to prevent hypothermia and its associated complications. Hypothermia, defined as a core body temperature below 36 °C, can lead to adverse outcomes such as increased surgical site infections, impaired wound healing, coagulopathy, and cardiovascular instability[1,2]. Therefore, maintaining normothermia is essential for optimal patient outcomes.

There are various strategies and techniques that can be employed to warm patients during surgery. One commonly used method is the administration of warm intravenous (IV) fluids. Spruce[3] found moderate-quality evidence that warm IV fluids kept patients warmer than room-temperature IV fluids during surgery. This method is effective in preventing heat loss and can help maintain core body temperature.

Another approach to warming patients during surgery is the use of active warming devices. Forced-air warming devices, such as surgical sheets or cotton blankets, are commonly used to warm patients passively. Nieh and Su[4] conducted a meta-analysis and systematic review that showed forced-air warming to be effective in preventing perioperative hypothermia in surgical patients. These devices blow warm air over the patient's body, creating a convective heat transfer that helps maintain body temperature.

In addition to active warming devices, other methods can be employed to warm patients during surgery. Lim and Lee[5] highlighted the importance of various warming strategies in keeping the body temperature stable in elderly patients undergoing surgery under general anesthesia or regional anesthesia. These strategies may include warm blankets, fluid warmers, and radiant warmers.

Furthermore, the use of warm cardioplegia during cardiac surgery is an essential technique for myocardial protection. James et al.[6] discussed the concepts and controversies surrounding warm blood cardioplegia and its role in preventing myocardial reperfusion injury during cardiac surgery. Warm cardioplegia involves the use of warm blood to arrest the heart, providing better myocardial protection compared to cold cardioplegia.

It is worth noting that warm ischemia time (WIT) is a critical factor to consider during surgical procedures. Prolonged warm ischemia is significantly associated with adverse post-

Address for Correspondence: Necati Üçler, Gaziantep University Faculty of Medicine, Department of Neurosurgery, Gaziantep, Türkiye
E-mail: necati_ucler@yahoo.com
ORCID ID: orcid.org/0000-0002-0561-5819

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operative renal function. Volpe et al.[7] reviewed the literature and found that minimizing WIT is crucial in surgeries such as partial nephrectomy and kidney transplantation.

Maintaining normothermia during surgery is essential to prevent hypothermia-associated complications. Strategies such as the administration of warm IV fluids, the use of active warming devices, and the implementation of various warming techniques can effectively warm patients during surgery. Additionally, specific considerations should be given to procedures involving WIT to minimize adverse outcomes. By implementing these warming strategies, healthcare providers can optimize patient outcomes and reduce the risk of perioperative complications.

This study was conducted to evaluate the perioperative effects of different active heating methods on patients who underwent spine surgery in the prone position.

MATERIALS AND METHODS

The study was conducted between March 1, 2022 and September 1, 2022 after approval by İzmir Tınaztepe University Health Sciences Scientific Research and Publication Ethics Committee (ethics committee number: 2022/19, date: 25.03.2022). Consent forms were obtained from all patients participating in the study. In our study, which consisting of 60 patients, 30 patients were included as the experimental group and 30 patients as the control group. Both the experimental and control groups were warmed with heated green covers in the operating room for 30 minutes before the surgery. The fluids given to both groups were at 36 degrees, so they were at body temperature. The experimental group was taken to the operating room and heated with a bottom-heated blanket device throughout the surgery. The patients' tympanic fever was measured every 15 minutes during the entire heating period. The control group was heated during the surgery with a heating device blowing hot air, and the patients' tympanic fever was measured every 15 minutes during the heating period. The experimental and control groups taken to the recovery unit were covered with pre-heated warm blankets, and the patients were transferred to the service 20 minutes after their vital signs were measured in this unit. Laboratory values of the patients were also taken after they went to the ward: laboratory values of the patients before, during, and after the surgery were compared.

Those with Cushing's syndrome, respiratory failure, congestive heart disease, liver, kidney or pancreatic failure were not included in the study. It was thought that the physiological status of these patients might affect the current values, and therefore, these patients were excluded from the study.

Lumbar stenosis cases that were operated on in the prone position, without instrumentation, and underwent single-level laminectomy were included in this study.

Statistical Analysis

The statistical analysis of the data was conducted using Statistical Package for Social Sciences version 25.0. Categorical data were presented as counts and percentages, while continuous data were expressed as means and standard deviations (and medians along with minimum and maximum values when applicable). For the comparison of categorical variables, chi-square and Fisher's exact tests were employed. The Shapiro-Wilk test was utilized to assess the normality of the distribution of the study parameters. For parameters that exhibited a normal distribution, the independent samples t-test was applied, whereas the Mann-Whitney U test was used for those that did not follow a normal distribution. A significance level of 0.05 was established for all statistical tests.

RESULTS

Demographic characteristics and the diagnostic status of the patients participating in the study are given in Table 1. While the average age of the patients was 53.5±14.8 years, Although the average age of the patients in the experimental group was younger, the age difference between the experimental and control groups was not significant (p=0.224). While 31 (51.7%) of the patients were found to be women, there was no significant difference in gender variable rates between groups (p=0.196). No significant difference was found between the presence of chronic disease and the rates of typical chronic patients in the groups (p=0.796; p=0.568, respectively).

The patients in the control group were applied the air insufflation system for an average of 2.36±0.2 hours. It was determined that a bottom heated blanket was applied to the patients in the experimental group for an average of 2.00±0.1 hours (Table 2). While the average time to wake up from anesthesia was 6.03±1.5 minutes in patients, findings on recovery time from anesthesia were found to be homogeneous between the experimental and control groups (p=0.741). The average post-operative day of stay was 3.82±1.2 days in patients. Although the average post-operative stay day was lower in the experimental group than in the control group, the difference was insignificant (p=0.064).

Table 3 shows the clinical and laboratory findings and the differences between the groups. While the average operating room temperature was 20.5±0.7 °C, it was determined that both groups had a similar average value (p=0.942).

The average anesthesia duration was found to be 2.40±0.4 hours in patients. It was determined that the duration of anesthesia was shorter in the experimental group than in the patients in the control group (p<0.001). Differences between groups in terms of vital signs during surgery.

When intraoperative vital signs and differences between the groups were evaluated, it was determined that the 15th and 30th minute systolic blood pressure averages were higher in the control groups than in the experimental groups (p=0.012; p=0.020, respectively). It was determined that the 15th and 30th minute averages of diastolic blood pressure were higher in the control groups than in the experimental groups (p=0.001; p=0.002, respectively). It was determined that the averages of

Table 1. Demographic characteristics of the patients and differences between the groups (n=60)

	Control group (n=30)	Experiment group (n=30)	Total (n=60)	χ^2	p
	n (%)	n (%)	n (%)		
Gender					
Woman	18 (60)	13 (43.3)	31 (51.7)	1,669	0.196
Male	12 (40)	17 (56.7)	29 (48.3)		
Body mass index					
Weak	4 (13.3)	3 (10.0)	7 (11.7)	0.203	0.903
Normal	13 (43.3)	13 (43.3)	26 (45.0)		
Fat	13 (43.3)	14 (46.7)	27 (43.3)		
Chronic disease	14 (33.3)	10 (33.3)	20 (33.3)	0.067	0.796
In those with chronic diseases (n=24)					
DM	1 (7.1)	-	1 (3.4)	1,131	0.568
Hypertension	9 (64.3)	10 (66.7)	19 (65.5)		
Hypertension+DM	4 (28.6)	5 (33.3)	9 (31.0)		
Marital status					
Single	1 (3.3)	4 (13.3)	5 (8.3)	1,964	0.161
Married	29 (96.7)	26 (86.7)	55 (91.7)		
Smoking	14 (46.7)	5 (16.7)	19 (31.7)	6,239	**0.012***
History of previous surgery	4 (13.3)	1 (3.3)	5 (8.3)	1,964	0.161
Age (mean ± SD)	55.8±13.3	51.2±5.9	53.5±14.8	t=1,230	0.224

* $p<0.05$, χ^2: Chi-square test, t: Independent student t-test. DM: Diabetes mellitus, SD: Standard deviation

Table 2. Findings regarding the patients' surgical processes and differences between groups (n=60)

	Control group (n=30)	Experiment group (n=30)	Total (n=60)		
	mean ± SD	mean ± SD	mean ± SD	t	p
Surgery time (hours)	2.28±0.3	2.00±0.1	2.14±0.2	5,461	**<0.001****
Operating room temperature	20.5±0.8	20.5±0.6	20.5±0.7	0.072	0.942
Anesthesia duration (hours)	2.65±0.2	2.14±0.3	2.40±0.4	7,716	**<0.001****
solution temperature	36.2±0.3	36.4±0.2	36.3±0.3	-2,700	**0.009****
IV solution temperature	36.2±0.3	36.5±0.2	36.3±0.3	-4,154	**<0.001****
Washing solutions temperature	36.2±0.3	36.4±0.2	36.3±0.3	-3,096	**0.003****
Fasting period before surgery	9.17±1.4	9.67±1.6	9.42±1.5	-1,299	0.199
Air blowing system application time	2.36±0.2	-	-	-	-
Bottom heated blanket	-	2.00±0.1	-	-	-
Application time (hours)	5.96±1.1	6.10±1.9	6.03±1.5	-0.333	0.741
Recovery time from anesthesia (min)	4.10±1.4	3.53±0.9	3.82±1.2	1,890	0.064
Post-operative stay day	4.90±1.5	4.40±0.0	4.65±1.3	1,506	0.137
Antibiotics used [n (%)]					
Cefazole	25 (83.3)	23 (76.7)	48 (80)	0.417	0.519
Desefine	5 (16.7)	7 (23.3)	12 (20)		

$p<0.05$, **$p<0.001$, t: Independent student t-test. SD: Standard deviation, IV: Intravenous

Table 3. Clinical and laboratory findings and differences between groups (n=60)

	Control group (n=30)	Experimental group (n=30)	Total (n=60)		
	mean ± SD	mean ± SD	mean ± SD	t/u	p
Body temperature	36.2±0.4	36.2±0.3	36.2±0.3	t=-0.183	0.855
Room temperature	23.3±0.6	22.7±0.9	23.0±0.8	t=3,200	**0.002****
Lymphocyte	24.2±11.1	24.6±8.5	24.4±9.8	u=-0.377	0.706
Platelet	309.2±89.3	287.7±70.2	298.5±80.4	t=1,035	0.305
MAP	72.8±4.5	78.1±4.5	75.5±5.2	t=-4,544	**<0.001****
Respiratory rate	19.5±1.4	18.5±1.9	19.0±1.7	t=2,131	**0.037***
Glasgow coma score	15.0±0.0	15.0±0.0	15.0±0.0	-	-
HB	12.4±1.7	12.3±0.9	12.4±1.3	t=0.230	0819
AST	20.3±7.4	22.4±8.6	21.4±8.0	t=-1,032	0,.306
Erythrocyte	4.33±0.5	4.16±0.4	4.25±0.5	t=1,387	0,171
ALT	20.9±11.1	20.6±8.9	20.8±9.9	t=0.129	0.898
WBC	7.89±3.2	7.54±2.2	7.71±2.7	t=0.498	0.620
BUN	15.4±7.4	13.4±4.3	14.4±6.1	t=1,305	0,197
CRP	3.17±3.1	7.19±9.8	5.18±7.5	t=-2,152	**0.036***
Sedimentation	15.7±16.2	16.2±17.9	15.9±16.9	u=-0.252	0.801

p<0.05, **p<0.001, t: Independent student t-test, u: Mann-Whitney U test. SD: Standard deviation, MAP: Mean arterial pressure, HB: Hemoglobin, AST: Aspartat aminotransferaz, ALT: Alanine aminotransferaz, WBC: White blood cells, BUN: Blood urea nitrogen, CRP: C-reaktif protein

mean arterial pressure values at the 0th minute, 15th minute, 30th minute, 45th minute, and 60th minute were higher in the experimental groups than in the control groups (p=0.015; p=0.016; p=0.019, respectively) (p=0.001; p=0.016). No significant difference was detected between the respiratory averages of the experimental and control groups (p>0.05). No significant difference was found between the saturation averages of the patients in the experimental and control groups (p>0.05). No mortality was observed in our patient groups where both heating methods were used.

DISCUSSION

Blood pressure, pulse, respiration, and saturation values of all patients included in this study. When body temperatures were within normal limits, universally similar physiological findings retained their numerical values, unless any other complications arose. It is thought that warming the patients in the experimental group with an electric blanket, and the patients in the control group with a blanket heated with compressed air is essential to keep the vital signs of the patients at expected values. Heating techniques in different modalities may be preferred to prevent perioperative hypothermia. When determining the suitable device, factors such as surgical access, user-friendliness, the size of the device, patient positioning, IV access locations, and the performance of the device should be considered. All devices can prevent vital signs from deteriorating by increasing body temperature. This information was parallel to the findings in this research. In the study, patients' vital signs were kept within normal limits by using different heating techniques.

Hypothermia can lead to adverse outcomes such as increased surgical site infections, impaired wound healing, coagulopathy, and cardiovascular instability[8]. Therefore, maintaining normothermia is essential for optimal patient outcomes.

During the perioperative period, an effective warming strategy should incorporate various measures to maintain intraoperative normothermia. This encompasses pre-anesthetic active warming, active warming throughout the surgical procedure, and precise monitoring of core temperature[8]. Active warming can be implemented using methods such as administering warm IV fluids, utilizing forced-air warming devices, applying warm cardioplegia, and employing various other warming techniques.

The administration of warm IV fluids has been shown to be effective in preventing heat loss and maintaining core body temperature during surgery[9]. It is advised to initiate active warming at least 30 minutes prior to the induction of anesthesia, unless this would post-pone emergency surgical procedures[9]. Forced-air warming devices, including surgical blankets or cotton sheets, facilitate convective heat transfer, which aids in preserving body temperature[8]. These devices are frequently utilized in surgical environments to provide passive warming for patients.

In addition to active warming during surgery, it is crucial to continue warming patients after surgery to prevent post-operative hypothermia. A study conducted in France found that despite forced-air warming devices, the prevalence of hypothermia remained high in patients undergoing surgery[10]. Therefore, it is important to implement effective warming strategies in the post-operative period.

The benefits of warming patients extend beyond preventing hypothermia. Warming patients before surgery has been shown to reduce blood loss and transfusion requirements[11]. It can also have positive effects on wound healing and surgical site infection rates[12]. Additionally, warming techniques such as warm compression can be beneficial in melting abnormal meibum and improving dry eye symptoms[13].

It is important to note that the choice of warming technique may vary depending on the surgical procedure and patient population. For example, a study conducted in Beijing found that only a small percentage of patients received active warming with space heaters or electric blankets during general anesthesia[14]. The application of warmed abdominal lavage solutions has been demonstrated to elevate patient temperatures during anesthesia in celiotomy procedures[15].

Active warming techniques, such as the administration of warm IV fluids and the use of forced-air warming devices, are effective in maintaining normothermia during surgery. When our study is evaluated together with the literature, the application of effective warming strategies not only increases patient comfort but also improves outcomes, reduces the risk of complications, and promotes optimal recovery.

Study Limitations

In this study, patients' vital signs and blood laboratory values were monitored until 24 hours after surgery by using different electrical heating methods. The infection status of the patients could not be determined in the study. With other studies, this research can be repeated in different groups with different patients with different heating methods, and additional information, such as infection findings and hospital discharge times, can be investigated. Additionally, the methods of heating techniques to be used before, during and after surgery in emergency cases could be evaluated. Although the heating techniques generally used in our study were compared, more meaningful results could have been obtained if the heating techniques were evaluated one by one and their results were discussed. Evaluating the techniques we compared with the surgical results in longer surgeries will be the subject of other studies.

CONCLUSION

Our study compared two different heating methods with similar anesthetic and surgical techniques. The physiological values of the patients to whom we applied both methods were statistically similar ($p>0.05$). Heating methods may be helpful in protecting patients from surgical and anesthesia risks, increasing their comfort, and ensuring the physiological state of surgical patients. It is advisable to assess the warming of patients on an individual basis, taking into account the specific type of surgery and the patient's morbidity. Additionally, heating should be routinely incorporated in suitable situations during the surgical procedure.

Ethics

Ethics Committee Approval: The study was approved by İzmir Tınaztepe University Health Sciences Scientific Research and Publication Ethics Committee (ethics committee number: 2022/19, date: 25.03.2022).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.B., A.T., N.Ü., Concept: B.B., A.T., Design: A.T., Data Collection or Processing: B.B., Analysis or Interpretation: B.B., Literature Search: A.T., N.Ü., Writing: B.B., N.Ü.

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