

# Comparison between General and Spinal Anesthesia for Changes of Core and Peripheral Body Temperature in Leg Surgery

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## Abstract

**Introduction:** The temperature changes in general and spinal anesthesia is still controversial and in this study is compared hypothermia in both groups.

**Materials and Methods:** In this double-blinded clinical trial, 60 patients under going leg surgery were divided into two groups. The peripheral, front and tympanic membrane temperature was measured before the induction and every half an hour until the recovery in the spinal and general groups. The data were evaluated by SPSS v.16 and  $p < 0.5$  was considered significant.

**Result:** The demographic data was not significantly different between the two groups. The prevalence of hypothermia in general and spinal anesthesia was 76.7% and 60%, respectively. The frontal temperature was significantly different between the two groups only at first 30 min ( $p = 0.02$ ). The core temperature was significantly different after the first hour until recovery between the two groups ( $p$ -value was 0.03, 0.04, and 0.03 at 60 min, 90 min, and recovery, respectively) and there was more reduction in general anesthesia ( $2.7^{\circ}\text{C}$  compared with  $2.2^{\circ}\text{C}$ ). No relationship was observed between age, weight, and ambient with frontal, and core temperature. Shivering in general and spinal anesthesia was 46.6% and 13.3%, respectively, which was not statistically different in spite of the clinical difference ( $p = 0.253$ ).

**Final conclusion:** Hypothermia was higher in general anesthesia after the first hour, which necessitated the need for monitoring of core temperature in the orthopedic surgeries lasting for more than half an hour. No significant relationship was observed between ambient and core temperature, but ambient changes were not too high in our study.

**Keywords:** Hypothermia; General anesthesia; Spinal anesthesia

## Introduction

The most common intraoperative temperature disorder during surgery is unintended hypothermia, its prevalence is 50% to 90% [1-4]. Hypothermia is the result of combining general anesthesia and exposure to the cold operation rooms. In general anesthesia, the threshold required for vasoconstriction and shivering is decreased by  $2-3^{\circ}\text{C}$ . The largest primary cause of hypothermia in most patients is the redistribution of body temperature from center

to the environment [5-7]. Neuraxial anesthesia also disturbs score and peripheral thermoregulation control, which is accompanied by hypothermia [8,9]. Postoperative hypothermia is associated with physiological adverse effects and postoperative complications. Several studies have proven that even mild hypothermia ( $1.5$  to  $2^{\circ}\text{C}$ ) causes adverse outcomes such as 3-fold increase in cardiac morbidity, 3-fold increase in wound infection, coagulopathy

and more need for allogeneic transfusion, long recovery, and longer hospitalization [10-13]. Another complication of hypothermia is postoperative shivering, which can lead to many hemodynamic and metabolic effects. Shivering increases the consumption of tissue oxygen and, consequently, pulmonary minute ventilation, cardiac work, patient discomfort, and recovery time [14].

Body temperature monitoring should be performed during general anesthesia in the patients whose surgery lasts for more than 30 min and during the spinal anesthesia of more than 60 min. Also, core body temperature should be maintained at about 36-37°C. Forced air blanket has the best and most efficient heating and is associated with less cost and more safety during surgery [15,16].

This study is aimed to examine and compare the changes of core and peripheral temperature in general and spinal anesthesia and also relationship between age, sex, operation duration, and ambient temperature with core temperature changes and postoperative shivering, which still has conflicting results in previous studies.

## Method and Materials

After the approval of Vice Chancellor for Research of University of Medical Sciences and Local Ethics Committee, this double-blinded randomized clinical trial was performed on 60 patients undergoing lower extremity surgery with ASA I, II. The patients with preoperative fever ( $T > 38^{\circ}\text{C}$ ), hypothermia ( $T < 36.5^{\circ}\text{C}$ ), spinal anesthesia contraindication, addiction, sensitivity to studied medication, blood transfusion during surgery, and surgery duration of more than 120 min were excluded. After obtaining a written consent, the patients were randomly divided using random numbers table and sealed envelope into two same groups, each with 30 patients.

After obtaining consent from the patients for spinal or general anesthesia and inclusion into the study, 5 ml/kg normal saline was injected into all the patients after venipuncture. The first group underwent spinal anesthesia with midline approach in the sitting position of L3-L4 or L4-L5 with the injection of 12-15 mg bupivacaine solution 0.5% as well as 25 µg fentanyl and, then, the

**Table 1:** Demographic and surgical parameters in two groups.

Parameters	Spinal Anesthesia Group	General Anesthesia Group	P-Value
Sex (F/M)	20-Oct	19-Nov	1
Age (years)	45.18±19.43	41.09±18.82	0.39
Weight (Kg)	71.48±15.06	67.74±12.1	0.29
Bleeding (ml)	96.05±95.3	96.61±93.02	0.11
Operation time (min)	101.96±24.84	108.54±31.99	0.36

## Prevalence and rate of hypothermia

Considering the temperature less than 36°C as hypothermia, the prevalence of hypothermia during the study was obtained 76.7% (23 out of 30 patients) in general anesthesia and, in the group

patients were returned to the supine position. The anesthesia level was measured by pinprick test and maintained at T8-T10. For hypotension ( $\text{Bp} \downarrow > 30$  mmHg or  $\text{SBP} < 90$  mmHg), 5-10 mg ephedrine was injected. Brady cardia was defined as  $\text{HR} < 50$  bpm and was treated with the intravenous injection of 0.5 mg atropine.

In the second group general anesthesia induced with 3 µg/kg fentanyl, 2 mg/kg propofol, and 0.5 mg/kg atracurium. After the tracheal intubation, anesthesia maintained with propofol (100 µg/kg), 50% oxygen, nitrous oxide, and fentanyl (50 µg) were used every half an hour.

The patients were monitored with heart rate, blood pressure, peripheral oxygen saturation, and ECG. The ambient, frontal, and tympanic membrane temperatures were evaluated before the induction of anesthesia, and the next 30 min until the end of surgery and transfer to the recovery room by a tympanic thermometer device (Genius 2 Electronic Thermometer). The patients with general anesthesia in the recovery room and those with spinal anesthesia during the surgery and until transfer to the ward was evaluated for shivering incidence.

## Statistical analysis method

The software used in this study was SPSS v.16 (Chicago, IL), and the significant level was considered less than 0.05. For the statistical analysis of the nominal qualitative variables, Chi-square test and Fisher's exact test were used. First, the quantitative variables were examined using normality test such as Kolmogorov-Smirnov test. For the quantitative variables, t-test or Mann-Whitney test were applied to compare both groups. In the evaluation of the changes during surgery, multiple measurement ANOVA was used in each group. In order to investigate the effect of the variables on body temperature changes, linear regression analysis was used.

## Result

The demographic information of the patients, bleeding rate, and surgery duration are shown in Table [1] and no significant difference was observed between the two groups (Table 1).

with spinal anesthesia, was observed 60% (18 out of 30 patients). Temperature reduction in the general and spinal anesthesia groups was up to 2.7°C and 2.2°C, in general and spinal anesthesia groups respectively.

## Core and peripheral body temperature changes

At the beginning of anesthesia, the average core body temperature in the regional and general anesthesia groups was equal to 36.67 and 36.40, respectively. And also, the peripheral body (frontal) temperature in the regional and general anesthesia groups was 34.83 and 34.24, respectively. No significant difference

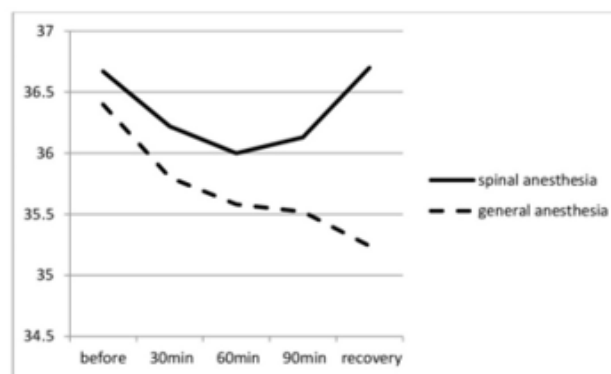
was observed between the two groups in terms of core and peripheral body temperatures at the beginning of the study and before the injection of the spinal or general anesthesia medication (p-value at peripheral and core temperatures was equal to 0.62 and 0.71, respectively). The core and peripheral body temperature changes in the patients during the study are shown in [Table 2].

**Table 2:** core and peripheral body temperature in two groups on duration of surgery.

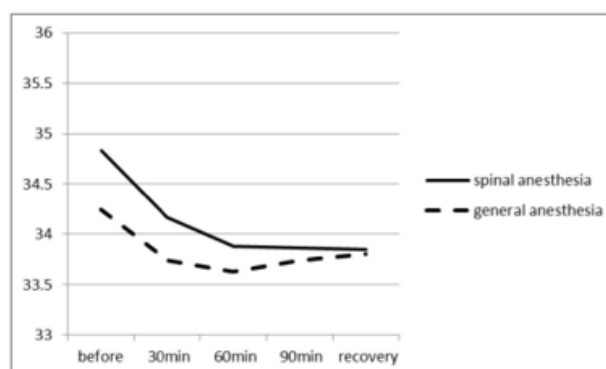
Core and Peripheral Body Temperature		Spinal Anesthesia Group	General Anesthesia Group	P-Value
Core Temperature (Tympanic) ° C	Before anesthesia	36.67±1	36.4±1.08	0.71
	30 min	36.22±0.86	35.08±0.84	0.23
	60 min	36±1.01	35.58±0.93	0.038
	90 min	36.13±0.85	35.52±0.95	0.392
	Recovery time	36.7±0.95	35.24±1.4	0.732
Peripheral Temperature (Frontal) ° C	Before anesthesia	34.83±0.95	34.24±1.31	0.62
	30min	34.17±1.05	33.74±1.02	0.02
	60 min	33.88±1.08	33.63±1.4	0.382
	90 min	33.86±1.1	33.74±1.51	0.392
	Recovery time	33.85±1.06	33.8±0.91	0.71

In the comparison of patients' peripheral body temperature at different minutes, the significant difference was only observed at 30 min between the general and spinal anesthesia groups (P=0.02).

At other minutes, no significant difference was observed between the two groups [Figure 1].



**Figure 1:** Comparison of central body temperature (tympanic membrane).



**Figure 2:** Comparison of peripheral body temperature (frontal skin surface).

In the comparison of core body temperature, no significant difference was found up to 30 min ( $p=0.20$ ). But later, during the study, the core temperature difference was increased between the two groups and this difference was statistically significant ( $p$ -value was 0.03, 0.04, and 0.03 at 60 min, 90 min, and recovery time, respectively) [Figure 2].

### Effective factors for hypothermia during surgery

There was no significant relationship between ambient and peripheral (frontal) body temperatures during the surgery in spinal anesthesia (at 30, 60, and 90 min as well as recovery time,  $p$ -value was 0.34, 0.15, 0.24, and 0.14, respectively). Also, no significant relationship was found between ambient temperature and core body (tympanic) temperature (at 30, 60, and 90 min as well as recovery time,  $p$ -value was 0.13, 0.59, 0.43, and 0.096, respectively). In general anesthesia, there was no significant relationship between ambient temperature and peripheral body (frontal) temperature (at minutes 30, 60, and 90 as well as recovery time,  $p$ -value was 0.09, 0.06, 0.17, and 0.72, respectively) and no significant relationship was found between ambient temperature and core body (tympanic) temperature (at minutes 30, 60, and 90 as well as recovery time,  $p$ -value was 0.82, 0.45, 0.60, and 0.76, respectively). Also, the other risk factors such as age and weight, no significant relationship was observed between the two groups. During the surgery, there was no significant relationship between mean arterial pressure changes and core body (tympanic) temperature (at minutes 30, 60, and 90 as well as recovery time,  $p$ -value was 0.93, 0.98, 0.50, and 0.50, respectively).

### Shivering during and after surgery

The incidence of shivering in the spinal anesthesia was 13.33% (4 cases) during the study; in shivering patients, the average operating time was 113.0 min and, in non-shivering cases, the average operating time was 100.0 min. But, the difference was not statistically different ( $p=0.253$ ). The incidence of shivering in the general anesthesia group was observed in 46.66% (14 cases) during the study and, in shivering patients, the average operating time was 115.3 min and in non-shivering patients was 102.18 min. But, the difference was not statistically significant ( $p=0.259$ ). In this study, no statistically significant relationship was observed between the incidence of shivering and core body temperature in both groups ( $p=0.41$ ).

## Discussion

Intraoperative hypothermia is a common issue after general or regional anesthesia and its prevention requires the attention of anesthetists as well as cooperation of surgeons and operating room personnel.

The prevalence of hypothermia in several studies has been reported up to 90%. In this study, in the general anesthesia group

and in the spinal anesthesia group, the prevalence of hypothermia during recovery was 76.7% and 60%, respectively. The rate of temperature reduction in the general and spinal anesthesia groups was observed up to 2.7°C and 2.2°C, respectively.

In this study, the core temperature reduction in the general anesthesia group was more significant than the spinal anesthesia group. In the general anesthesia group, the core body temperature was decreased on average from 36.4°C at the beginning of surgery to 35.2°C in recovery (the average decrease of 1.2°C and maximum decrease of 2.7°C). In the spinal anesthesia group, at the first hour, the core temperature was decreased on average from 36.7 to 36°C (average of 0.7°C and maximum of 2.2°C); but then, it was increased again and reached 36.7°C. This temperature difference between the general and spinal anesthesia groups was significant after the first hour. According to different studies, the core temperature decrease during general anesthesia at the first hour, due to their distribution of temperature and dysregulation of the core temperature and vasodilation after anesthetic drugs, has been observed at 0.5-1.5°C (2, 5). In this study, in the general anesthesia, the average decrease of temperature at the first hour was 0.8°C (from 36.4 to 35.6), and the average temperature decrease was less as the surgery continued (0.4°C). In spinal anesthesia, according to some studies, the core temperature decrease is reported to be similar to general anesthesia, due to the anesthesia and disruption in lower extremity; even sometimes higher temperature decrease is observed (17, 18). In other studies, the decreased core temperature in spinal anesthesia has been reported to be less than general anesthesia (19, 20). In the present work, core temperature in the spinal anesthesia at the first hour was decreased less than the general anesthesia, but in the spinal anesthesia, there was no higher temperature reduction and even the core temperature was increased and returned to its initial rate. Both general and spinal anesthesia changed the function of the autonomic nervous system in the body, which had a great impact on the regulation of body temperature. In general anesthesia, the effect of anesthetics on the central nervous system disrupted the regulation power of central temperature through inhibiting the hypothalamic system. In contrast, in the spinal anesthesia, the central nervous system was not affected. The relative inhibition of central regulation response against peripheral regulation system might explain better maintenance of the central temperature in the spinal anesthesia group.

The age of more than 60, low body weight, poor nutrition, disturbing conditions for thermoregulation (diabetic poly neuropathy, hypothyroidism, and consumption of sedatives or psychedelic drugs), higher class of ASA I, preoperative hypothermia, combination of general and spinal anesthesia, operation time over 2 h, and infusion of a large volume of fluids or cold blood increase the risk of hypothermia [8, 16-17].

The temperature of operation room, especially when being less than 21°C, has an effect on postoperative body temperature in patients. Hence, the minimum operation room temperature of 21°C and 24°C is recommended for adults and children, respectively. It has been reported in previous studies that ambient temperature can affect the body temperature and increase the core temperature reduction in the patients with general anesthesia, especially because surgeons can work easily in cooler environment (8, 21) and also warmer environment facilitates the maintenance of core body temperature. The effect of ambient temperature on the body temperature of patients has not been clearly described. In Goldberg's study on 101 patients with inhalation anesthesia, ambient temperature had no effect on body temperature (22). Morris et al. defined the temperature of 21°C as the critical temperature for operation rooms and showed that at the ambient temperature of more than 21°C, the body temperature did not change during general anesthesia (23). Stevens et al. also demonstrated that the ambient temperature of 21°C was enough to maintain the body temperature during epidural anesthesia, but a warmer environment was required to maintain the core temperature in general anesthesia [24].

In 2000, Gamal et al. showed that the operation room temperature had an effect on the postoperative body temperature of patients (25). In the present study, the ambient temperature in general and spinal anesthesia was from 25.8 to 25.9 and from 24.9 to 25.6, respectively, and there was no temperature difference between the two groups. Also, no significant temperature reduction was observed in the operating room. In the present investigation, no relationship was observed between ambient and core temperature, which might be related to lack of significant temperature change in the operating environment.

In the elderly patients, the maintenance power of core body temperature was even decreased in the awakened people. Some inconsistent results have been obtained in the results and aging is in conflict with temperature regulation or has no effect. However, in most studies, age range is wide and not limited to old age. In the present study, age and weight had no significant effect on core and peripheral body temperature changes of the patients.

Postoperative shivering occurs in 10% to 60% of the patients after general and regional anesthesia [26], respectively, and treated by active warming and drugs such as pethidine and tramadol. This complication depends on age, sex, anesthetics, and surgery type [27]. The prevalence of postoperative shivering in this study was 46.7% in the general anesthesia group and 13.37% in the spinal anesthesia group; it was 3.5 times higher in spinal than general anesthesia groups. In this study, there was no significant relationship between surgery duration, core body temperature, and shivering rate.

In conclusion, intraoperative hypothermia is common and 76.7% and 60% in general and spinal anesthesia respectively. Core temperature reduced after 1 hour in general anesthesia, but not in spinal anesthesia. There was no relationship between core temperature with ambient temperature, age and weight in this study.

### Acknowledgement

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### Conflicts of Interest

No conflicts of interest.

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