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Does Laminar Airflow in the Operating Room During Total Knee Arthroplasty Lead to More Perioperative Hypothermia Compared to Conventional Airflow?: A Randomized Clinical Trial

Total Diz Artroplastisi Sırasında Ameliyathanedeki Laminar Havaakımı Klasik Havaakımından Daha Fazla Perioperatif Hipotermiye Neden Olur Mu? Randomize Klinik Araştırma

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ÖZ

Amaç: Spinal anestezi vücudun termoregülatuar yanıtını bozar, sıklıkla özellikle total diz artroplastisi (TKA) gibi major cerrahilerde istenmeyen perioperatif hipotermi (İPH) (<36ºC) gelişmesine neden olur. Laminar havaakım sistemli ameliyat odalarındaki (LAS-OR) hava akımının yönü, konvensiyonel havaakım sistemli ameliyat odalarındakinin (CAS-OR) aksine, doğrudan ameliyat masasına doğrudur. Bu araştırmadaki amacımız "Total diz artroplastisi sırasında ameliyathanedeki laminar havaakımı klasik havaakımından daha fazla perioperatif hipotermiye neden olur mu?" sorusunu cevaplamaktır.
Araçlar ve Yöntem: Bu çalışma prospektif, randomize kontrollü bir araştırmadır. Hastalar grup L (LAS-OR' da ameliyat edilenler) (n=110) ve grup C (CAS-OR'da ameliyat edilenler) (n=110) basit randomizasyonla, kapalı zarf metodu kullanılarak iki gruba ayrıldı. İPH frekansları karşılaştırıldı. (Clinical trial kayıt numarası/tarih: IRCT20180324039145N4 / 2018.10.31)
Bulgular: Grup L'de 94 hastanın grup C'de 89 hastanın verileri değerlendirildi. TKA sırasında İPH frekansı %56.8 'iken (183 hastanın 104'ünde), grup L ve grup C arasında istatiksel fark bulunmamıştır (%62.8(94 hastanın 59'u) & %50.6 (89 hastanın 45'i), p=.096). Yüz beşinci dakikada, grup L'de 0.76 (±0.47) ºC (95%CI (0.61 to 0.91)) sıcaklık azalması varken buna karşı grup C'de 0.74 (±0.51) ºC (95%CI (0.58 to 0.90), p=.823) sıcaklık azalması bulunmuştur.
Sonuç: Spinal anestezi altında total diz artroplastisi sırasında laminar ve konvensiyonel hava akımlı odalardaki İPH frekansları arasında fark yoktur.

Anahtar Kelimeler: diz artroplastisi; hasta güvenliği; intraoperatif hipotermi; laminar hava akımı; spinal anestezi

ABSTRACT

Purpose: Spinal anesthesia disrupts the body's thermoregulatory response, often leading to undesired perioperative hypothermia (<36ºC), especially in major surgeries such as total knee arthroplasty (TKA). In operating rooms with a laminar airflow system (LAS-OR), the airflow direction differs from conventional airflow systems (CAS-OR) by being directed directly onto the surgical table. The aim of this study is to answer the question, "Does laminar airflow in the operating room during total knee arthroplasty lead to more perioperative hypothermia compared to conventional airflow?"
Materials and Methods: This study is a prospective, randomized controlled trial. Patients were divided into two groups, Group L (operated in LAS-OR) (n=110) and Group C (operated in CAS-OR) (n=110), using simple randomization with sealed envelope method. The frequencies of perioperative hypothermia (IPH) were compared between the groups. (Clinical trial registration number/date: IRCT20180324039145N4 / 2018.10.31)
Results: In Group L, data from 94 patients and in Group C, data from 89 patients were evaluated. During TKA, the frequency of perioperative hypothermia (IPH) was 56.8% (104 out of 183 patients), with no statistical difference found between Group L and Group C (62.8% (59 out of 94 patients) vs. 50.6% (45 out of 89 patients), p=0.096). At the 105th minute, Group L experienced a temperature decrease of 0.76 (±0.47) ºC (95% CI: 0.61 to 0.91), whereas Group C had a temperature decrease of 0.74 (±0.51) ºC (95% CI: 0.58 to 0.90), with no significant difference observed (p=0.823).
Conclusion: There is no difference in the frequency of perioperative hypothermia (IPH) between operating rooms with laminar and conventional airflow during total knee arthroplasty under spinal anesthesia.

Keywords: intraoperative hypothermia; knee arthroplasty; laminar airflow; spinal anaesthesia; patient safety

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INTRODUCTION

Inadvertent perioperative hypothermia (IPH), defined as the core temperature lower than 36°C, causes altered anaesthetic drug metabolism, cardiac arrhythmia, and increases surgical site infection (SSI), coagulopathy, transfusion requirements, and ultimately leads to increased morbidity and mortality.[1-3] Therefore, perioperative temperature monitoring is standard in the current guidelines of all procedures lasting more than 30 minutes.[4,5]

Major surgeries, such as total knee arthroplasty (TKA), are a risk factor for IPH.[6] TKA is frequently performed in the middle-aged and older patients with regional anesthesia. The heat loss during regional anesthesia and frequency of IPH changes according to the block level and duration of the procedure. The rate of IPH is reported as 10.7- 32.6% in current studies on TKA.[7,8] The frequency of IPH depends on the age and body mass index (BMI) of the patient, type and duration of surgery and anesthesia, size of the surgical field, intravenous fluid, and blood products used during the procedure.[2]

One of the factors affecting the development of IPH is the operating room (OR) temperature.[9] Heating, ventilation, and air-conditioning (HVAC) systems ensure certain constant temperatures in the OR. These systems regulate environmental factors such as indoor temperature, humidity and airflow, provide a clean airflow in the surgical area, and ensure comfort for the patient and surgical team.[10] Nowadays, especially to prevent SSI, laminar airflow HVAC systems (LAS-OR) are frequently used in orthopedic ORs.[11] However, there are also still operating rooms with conventional airflow HVAC systems (CAS-OR). The direction of the airflow in LAS-OR is direct to the operating table, unlike CAS-OR. The distribution of airflow, temperature, and humidity in these two OR systems are different from each other.[10]

The heat loss from the body mostly occurs with radiation and convection during surgery, which varies depending on the velocity of airflow and ambient temperature in the OR.[12] Accordingly, does the type of airflow in the OR affect the speed and frequency of IPH? In the cohort study of Yang et al., it was stated that the use of LAS-OR was a high-risk factor of IPH.[13] However, to investigate this, randomized studies on specific patient groups are necessary; accordingly, we designed this randomized clinical trial.

In our study, we aimed to answer the question, "Does laminar airflow in the operating room cause more perioperative hypothermia than conventional airflow during total knee arthroplasty?".

MATERIALS and METHODS

Ethical Considerations

We received approval for the study from the Ethics Committee for Clinical Investigations of Ahi Evran University (27.3.2018 No:2018-06/58). The study was registered with IRCT20180324039145N4/2018.10.31).

We planned our research according to the current Helsinki Declaration guidelines. During the preoperative visit, we informed eligible patients about the study and those who were willing to participate signed informed consent forms voluntarily.

Study Design

The study was a prospective, controlled, randomized trial.

Specifications of Operating Rooms

There are 10 ORs in Kırşehir Education and Research Hospital theatre suite. Four are LAS-ORs with a vertical single large diffuser (SLD) system (Figure 1). The other six are CAS-ORs, which have a vertical multi-inlet system, nothing on the ceiling over the operating table (Figure 2). Validation tests of the ORs are performed regularly (ISO 14644 and DIN 1946 standard). All OR classifications are ISO CLASS 7.

We used a LAS-OR and a CAS-OR, the validation test results of which were similar for this research.

Figure 1. Laminar airflow (LAS-OR) system.

Figure 2. Conventional airflow (CAS-OR) system.

Patients, Inclusion and Exclusion Criteria

We examined a total of 315 patients who underwent TKA between 2018 and 2019. We included patients who were American Society of Anesthesiologists (ASA) risk groups I-III in the study, and each underwent elective primary unilateral TKA under spinal anesthesia.

We excluded patients who were hypothyroid, hyperthyroid, those who had corticoadrenal insufficiency, and central or peripheral neurologic disorders. We also included no bilateral surgeries or revision surgery.

During the surgical procedure, patients who required general anesthesia due to prolonged surgery, received blood transfusions, or were administered medications such as ephedrine or atropine for hypotension or bradycardia, were excluded from the study and not included in the statistical analysis.

Groups, Sample Size and Randomization

We defined two groups as group L (patients who were operated under LAS-OR) and group C (patients who were operated under CAS-OR).

We performed a preliminary study on 20 patients from each group. In the preliminary study, we detected the rates of IPH (62%, 50%, respectively). Based on these results, we calculated the sample size using the G*Power 3.1.9.2 statistical program (α=0.05, 1-β=0.95, effect size w=0.247, df=1).[14] In total, we determined the sample size of our study as about 213 patients. We included 220 patients in our study and divided the patients into group L (n=110) and group C (n=110) using simple randomization, as 1:1, respectively, with the closed envelope method.

Practice

According to the randomization, we received the patients inside the LAS-OR or CAS-OR.

The researcher recorded the age, sex, BMI (kg/m^2) of the patients, the temperature (°C) and humidity (%) of the OR, and the amount of intravenous (mL) and irrigation fluid (mL) used during surgery.

The anesthesia technician measured and recorded patients' tympanic temperature with Braun IRT6520 (Braun, Germany) before spinal anesthesia (T_0(°C)) and then every 15 minutes during surgery (T_n(ºC)). (T_0(°C): $Time_0$ (Temperature before the application of spinal anaesthesia) and T_n(ºC): $Time_n$ (Temperature at the n^{th} minute after the application of spinal anaesthesia)).

We did not administer any sedative drugs for premedication. Preoperatively, we initiated intravenous infusion of 0.9% NaCl at a rate of 10 mL/kg/hour. During the procedure, we monitored patients' noninvasive blood pressure (NIBP), pulse oximetry saturation (SpO2), and electrocardiography (ECG). Spinal anesthesia was administered to patients in the sitting position, at the L3-4 or L4-5 lumbar interspace, using a 26-G atraumatic spinal needle (Atroucan, Braun, Germany), with 15 mg of heavy bupivacaine 0.5%.

The patients were placed in the supine position and performed the surgical procedure when the sensory block in the pinprick test was detected at >T12 within 5 minutes of spinal block administration.

Ephedrine was administered intravenously (5 mg bolus) for hypotension, defined as a decrease in systolic arterial pressure of ≥20% from baseline. Atropine (0.5 mg) was used for bradycardia, defined as a heart rate <60 beats per minute. These patients were excluded from the study and not included in the statistical analysis.

Patients who required transfusion of blood products, such as red blood cells, and fluid infusion due to perioperative anemia (defined as hemoglobin concentration <9 g/dL) were excluded from the statistical evaluation.

Intravenous and irrigation fluids were not warmed before and during TKA procedures.

A tourniquet was applied to all patients during total knee arthroplasty (TKA). After the surgical field was sterilized, the patient was covered with standard surgical cotton drapes.

Perioperative hypothermia (IPH) was defined as a core temperature below 36°C. If we detected a tympanic temperature below 36°C during surgery, we used a Thermacare TC3249 convective warming system (Gaymar, USA) to warm the patient. These patients were categorized as experiencing IPH. We did not calculate the temperature change for these patients for the remainder of the procedure because they were warmed. Patients experiencing excessive shivering were treated with intravenous 5 mg pethidine.

Statistical Analysis

In this research, the hypothesis "There is no difference between the frequency of IPH in LAS-OR and CAS-OR." was tested.

The study's primary outcome was rates of IPH between groups. We compared using the Chi-square test.

Additionally, we compared the basic data such as sex, ASA risk group, patient BMI, surgical times, spinal anesthesia level, the amount of intravenous and irrigation fluid used during surgery, the temperature and the humidity of the OR and the change in tympanic temperature.

We used the IBM SPSS 23.0 (IBM Corp., Armonk, NY, USA) program to analyze the data of the study. We used descriptive statistical methods (frequency, percentage, mean, standard deviation, median, 25^{th} to 75^{th} percentile, 95% confidence intervals (CI) to analyze the data. We analyzed the normality of data distribution using the Shapiro-Wilk tests. According to the presence of normally distributed data, we used the independent samples t-test or the Mann-Whitney U test. P<.05 was considered statistically significant.

RESULTS

During the study, we evaluated 315 patients who underwent total knee arthroplasty (TKA) surgery. Ninety-five patients who did not meet the inclusion criteria were excluded. The study included 220 patients who underwent TKA under spinal anesthesia, comprising 152 females and 68 males (110 patients in each group, as shown in Figure 3).

During the study, medical therapy and fluid replacement were administered to 13 patients in Group L and 18 patients in Group C due to bradycardia or hypotension during the procedure. Blood replacement was administered to two patients in each group. Additionally, general anesthesia was performed on two patients in both groups. These patients were excluded from the final statistical evaluation (Figure 3). At the conclusion of the study, we statistically analyzed the data from 94 patients in Group L and 89 patients in Group C.

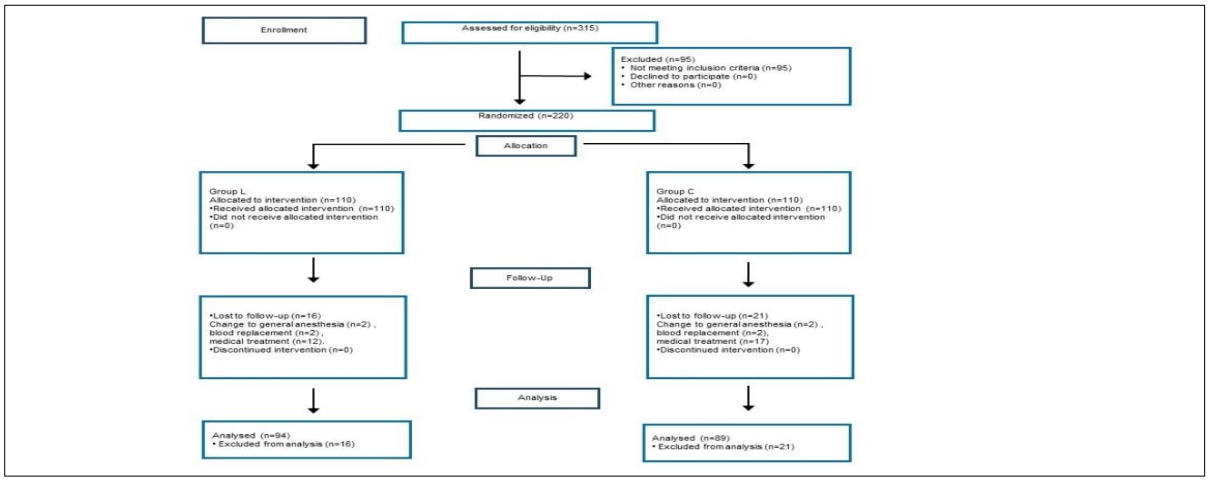

Figure 3 CONSORT Flow Diagram.
Group L: laminar airflow system, Group C: conventional airflow system.

Table 1. Baseline characteristics.

Variables		Group L (n=94)	Group C (n=89)	P
Sex, *n* (%)	Female	73 (77.7%)	79 (88.8%)	.071*
	Male	21 (22.3%)	10 (11.2%)	
ASA, *n* (%)	I	9 (9.6%)	5 (5.6%)	.330*
	II	54 (57.4%)	60 (67.4%)	
	III	31 (33.0%)	24 (27.0%)	
Spinal block level, *n* (%)	T-6	25 (26.6%)	16 (18.0%)	.704*
	T-7	13(13.8%)	15 (16.9%)	
	T-8	28 (29.8%)	29 (32.60%)	
	T-9	14 (14.9%)	13 (14.6%)	
	T-10	14 (14.9%)	16 (18.0%)	
Age (year)		63.51 (±7.15)	62.58 (±6.07)	.347†
		63.00 [59.00 to 69.00]	62,00 [59.00 to 66,00]	
		62.05 to 64.98	61.30 to 63.86	
BMI (kg/m^2)		32.59 (±5.40)	33.29 (±4.92)	.364†
		33.00 [29.00 to 37.00]	33.00 [30.00 to 36.00]	
		31.48 to 33.70	32.25 to 34.33	
Operation times (min)		112.19 (±34.14)	114.70 (±28.74)	.232‡
		105.00 [90.00 to 120.00]	110.00 [95.00 to 135.00]	
		105.20 to 119.18	108.64 to 120.75	
Operation room temperature (ºC)		21.28 (±1.05)	21.41 (±0.86)	.154‡
		21.00 [21.00 to 22.00]	22 [21.00 to 22.00]	
		21.07 to 21.50	21.23 to 21.59	
Operation room humidity (%)		33.12 (±12.95)	36.29 (±13.75)	.198‡
		28.00 [23.00 to 43.00]	35.00 [24.00 to 50.00]	
		30.46 to 35.77	33.40 to 39.19	
Intravenous fluid volume (mL)		1434.04 (±423.96)	1513.48 (±451.56)	.254‡
		1500 [1200 to 1600]	1500.00 [1200 to 1800]	
		1347.21 to 1520.88	1418.36 to 1608.61	
Irrigation fluid volume (mL)		4156.38 (±2208.85)	3921.35 (±1734.83)	.924‡
		4000 [3000 to 5000]	4000 [3000 to 5000]	
		3703.97 to 4608.80	3555.90 to 4286.80	

Group L: laminar airflow system; Group C: conventional airflow system; ASA: the American Society of Anesthesiologists risk group; BMI: Body mass index;
* Chi square test. † Independent Samples Test. ‡ Mann-Whitney U Test.
The data are presented as *n* (%), mean (±SD) and median [25th to 75th percentile], and 95% confidence intervals (CI).

The patients' mean age and BMI were 63.06 (±6.647) years and 32.93 (±5.17) kg/m^2, respectively.

We detected the mean surgical time as 105 (90 to 135) minutes. The mean intravenous and irrigation fluids used during surgery were 1500 (1200 to1700) mL, 4000 (3000 to 5000) mL, respectively, when we evaluated the data of all the procedures. We found no significant difference between the groups according to the basic data (Table 1).

In total, the incidence of IPH was 56.8% (104 of 183 patients) during TKA, and there was no significant difference between group L and group C [62.8% (59 of 94) vs 50.6% (45 of 89), p=0.096, respectively] (Table 2).

Table 2. Comparison of the incidence of Inadvertent perioperative hypothermia during total knee artroplasty in Group L and Group C.

Time	**Total IPH**	**Group L**	**Group C**	
	IPH (*n*) / Total (*n*)	**IPH-L (*n*)/ L (*n*)**	**IPH-C (*n*)/ C (*n*)**	***P***
	(%)	**(%)**	**(%)**	
T_0	0/183	0/94	0/89	
T_{15}	10/183	3/94	7/89	
	(5.5%)	(3.2%)	(7.9%)	
T_{30}	35/183	17/94	18/89	
	(19.1%)	(18.1%)	(20.2%)	
T_{45}	48/183	28/94	20/89	
	(26.2%)	(29.8%)	(22.5%)	
T_{60}	60/181	34/92	26/89	
	(33.1%)	(37.0%)	(29.2%)	
T_{75}	69/178	40/91	29/87	
	(38.8%)	(44.0%)	(33.3%)	
T_{90}	71/164	41/85	30/79	
	(43.3%)	(48.2%)	(38.0%)	
T_{105}	60/132	32/65	28/67	.391*
	(45.5%)	(49.2%)	(41.8%)	
T_{120}	46/85	24/40	22/45	
	(54.1%)	(60.0%)	(48.9%)	
T_{135}	30/55	14/24	16/31	
	(54.5%)	(58.3%)	(51.6%)	
T_{150}	15/26	9/13	6/13	
	(57.7%)	(69.2%)	(46.2%)	
T_{165}	9/12	7/8	2/4	
	(75.0%)	(87.5%)	(50.0%)	
T_{180}	4/5	4/4	0/1	
	(80.0%)	(100.0%)	(0.0%)	
Total	104/183	59/94	45/89	.096*
	(56.8%)	(62.8%)	(50.6%)	

IPH: Inadvertent perioperative hypothermia; L: laminar airflow system; C: conventional airflow system; T_0: Time (before the application of spinal anesthesia) T_n: Time (n. minute after the application of spinal anesthesia). The data are presented as *n* (%).
*Pearson Chi square.

Core temperature decreased by a mean 0.58 (±0.42) °C in all patients at the end of the 60th minute. The decrease of tympanic temperature at 105th minute was in group L 0.76 (±0.47) 95%CI (0.61 to 0.91) vs in group C 0.74 (±0.51) 95%CI (0.58 to 0.90), p=.823. The tympanic temperature data of the patients during the procedure are presented in Figure 4.

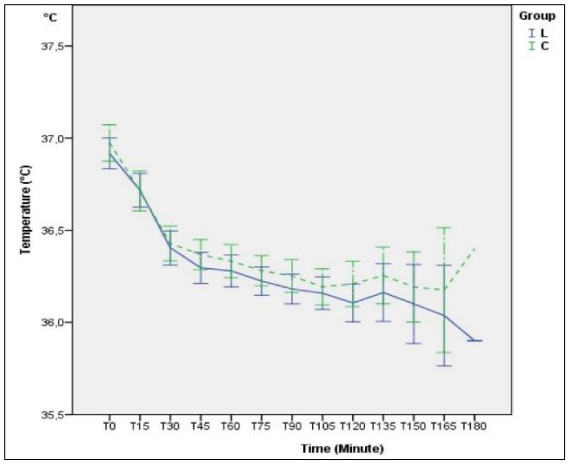

Figure 4. Tympanic temperature measurements.
L: laminar airflow system. C: conventional airflow system.
T_0: Time (before the application of spinal anaesthesia) T_n: Time (n. minute after the application of spinal anaesthesia).
The data (ºC) are presented as mean (%95CI).

DISCUSSION

For patient safety during major surgery under anesthesia, the risk factors of IPH are determined and preventive measures provided.[6] There are many studies on risk factors for IPH, such as low OR temperature and cold intravenous-irrigation fluids in the literature.[15,16] However, there are insufficient randomized studies in the current literature to answer whether laminar airflow aimed directed directly towards the patient in the OR is an additional risk factor for IPH. As a result of this research, we found that laminar airflow in OR was not a risk factor for IPH during TKA.

Body temperature monitoring is a critical component of perioperative patient safety. Following evidence demonstrating that perioperative hypothermia (IPH) increases morbidity and mortality, body temperature monitoring has become a standard practice in current guidelines for patient monitoring.[2,17]

Numerous risk factors for perioperative hypothermia (IPH) have been identified, which depend on factors such as patient characteristics, the type of surgery and anesthesia, and the preoperative administration of sedative agents like midazolam.[17,18] By a different mechanism, we know that both general and regional anesthesia disrupts the thermoregulator response of the body and causes heat loss. The thresholds triggering vasoconstriction and shivering decreases by about 0.6°C with spinal anesthesia, proportional to the number of spinal segments blocked.[19] In our study, we assessed the temperature changes and IPH rates among patients undergoing TKA under spinal anesthesia. We standardized the method of spinal anesthesia for all patients included in the study. Patients who received general anesthesia or deep sedation due to prolonged surgery were excluded from our analysis. The spinal blockade was achieved between T6 and T10, and the levels of blockade were comparable between both study groups.

IPH frequently occurs during major surgeries.[6,20] TKA, which is in the major surgery group, is being performed with increasing frequency, especially in older patients.[8] TKA is associated with some risk factors for IPH, such as older patients, long-duration surgery, and the need for transfusion of excess fluid and blood products.[6,21]

In the current literature, varied rates of IPH are reported during TKA.[6,7,22-24] In our study, we observed significantly higher rates of IPH compared to those reported in existing literature. Scholten et al. reported an IPH rate of 10.7% during TKA in a prospective observational cohort study. According to their findings, female sex and spinal anesthesia were identified as risk factors for IPH. A forced-air warming system was uniformly used for all patients in their study as the standard practice.[7] In a prospective observational study by Leijtens et al., 257 patients undergoing TKA were evaluated, and the incidence of IPH was determined to be 28.0%. Patients under both spinal and general anesthesia were included in this study. The mean surgical time was determined to be 54 minutes.[22] In the study by Matos et al., hypothermia rates were reported as 20.6% during surgeries lasting more than an hour, 47.1% postoperatively, and a total of 72.6%. In this study, it was found that patients did not have low preoperative temperatures, and it was demonstrated that a low operating room temperature was a risk factor for hypothermia. All patients in the study were treated with an upper-body forced-air warmer.[24]In our study, we observed a higher frequency of perioperative hypothermia (IPH) compared to previous studies (56.8%). Unlike those studies, we did not utilize a forced-air warming system to maintain the patient's body temperature during surgery. This difference in warming methods may explain the discrepancy in IPH rates between our study and previous ones.This may have reduced the ratio of IPH in their

cases.In another retrospective study, Willams et al. evaluated 1083 TKAs. They reported the incidence of IPH as 11.2%. The study did not standardize interventions such as anesthesia type, fluid warming, and use of warming devices..[23]

Studies on perioperative hypothermia in the current literature focussed on other risk factors, such as room temperature, anesthesia type, BMI, and duration of surgery.[7,22-24] In our study, risk factors such as patient age, ASA classification, BMI, and surgical time were similar between both groups. Additionally, we observed that the frequency of IPH decreased when irrigation and intravenous fluids were warmed during surgery. [16] Thus, the use of an active perioperative hypothermia prevention strategy is strongly recommended.[25] To standardize these factors, we administered irrigation and intravenous fluids at room temperature to the patients.

In the study of Matos et al., environmental factors such as low OR temperature are identified as a risk factor for IPH.[24] On the other hand, according to the result of the randomized trial of Pei et al., the ambient temperature of the operating room has an insignificant effect on the core temperature of forced-air warmed patients, but only a minor effect on patients passively insulated.[26] However, other environmental factors such as air velocity, airflow direction, and humidity in the operating room have not been investigated in this context. Moreover, in most studies, typically no information is given on the HVAC system in the OR.[7,22-24]

HVAC systems with a laminar flow are also a risk factor for IPH, according to Yang et al.[13] In LAS-ORs, the laminar airflow flows vertically (ceiling-mounted) or horizontally (wall-mounted) to the operating table. In contrast, CAS-ORs, turbulent airflow, which is non-laminar, is introduced from various ceiling or wall-mounted inlets into the operating room..[11] Do laminar airflow HVAC systems, which were introduced to provide thermal comfort and a clean surgical area, increase body temperature loss? Our research's principal starting point was the multi-center observational study of Yang et al.[13] Unlike Yang et al., we found no evidence to support that laminar flow in the operating room is a risk factor for IPH more than conventional airflow in our prospective, randomized study.

Limitation

It is known that the position of operating lights and an open door of the OR can affect the direction and velocity of laminar airflow.[27,28] Unfortunately, during our study, we were unable to standardize the positioning of operating lights and the opening of the operating room door. Additionally, there are limitations associated with core temperature measurements using tympanic methods. Sessler has highlighted that "infrared tympanic" thermometers and "temporal artery" thermometers are not sufficiently accurate for clinical use when measuring tympanic temperature. However, tympanic temperature measurement continues to be widely used in our hospital, particularly during regional anesthesia.

In our study, several factors contribute to perioperative hypothermia, including the use of a tourniquet and administration of cold intravenous fluids. These factors were standardized and applied uniformly in both study groups.

In addition to preventing surgical site infections (SSI) and IPH in patients, it is challenging to ensure thermal comfort for both the operating team and patients in the OR..[30,31] Nowadays, new HVAC systems are under development to try to meet these conditions.[32] HVAC systems in ORs in modern hospitals are built according to specific guidelines adopted by that country. These guidelines vary from country to country but generally encompass similar standards.[30,31]

According to our study results, there is a need for more randomized controlled multidisciplinary clinical trials that comprehensively evaluate environmental factors. These studies are essential to enhance patient thermal safety and establish new evidence-based practices. Additionally, they can provide guidance to engineers in designing and constructing optimal ORs and HVAC systems.

Conclusion

Inadvertent perioperative hypothermia is a common problem during major surgeries, especially TKA under spinal anesthesia. Therefore, it is crucial to closely monitor the core temperature of patients undergoing TKA under spinal anesthesia. According to current guidelines, IPH prevention and treatment strategies should be applied in a standardized way for all patients.

There were no differences between laminar and conventional airflow in the operating room regarding the frequency of IPH during TKA under spinal anesthesia. The risk of perioperative hypothermia of laminar and conventional airflow is similar.

Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

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Ethics Committee Permission

Approval was received for this study from Ahi Evran University Faculty of Medicine Clinical Research Ethics Committee (dated 27.3.2018 and numbered 2018-06/58).

Authors' Contributions

Concept/Design: RD. Data Collection and/or Processing: RD, FÇ, MY. Data analysis and interpretation: RD, FÇ, ZÜ. Literature Search: RD, MY, ZÜ. Drafting manuscript: RD, MY, ZÜ. Critical revision of manuscript: RD, FÇ.

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