Original Article

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The Truth We Cannot See; Hypothermia in Patients Under Spinal Anesthesia

Göremediğimiz Gerçek; Spinal Anestezi Altındaki Hastalarda Hipotermi

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ABSTRACT

Objective: *The frequency of using a temperature monitor in patients under spinal anesthesia is lower than desired. Besides, it is open to debate how and from where temperature monitoring should be done most practically in awake patients. In this study, we investigated the incidence of hypothermia in geriatric patients under spinal anesthesia and compared the temperature measurement methods.*
Method: *Preoperative and postoperative temperature monitoring were compared with three different measurement methods in elderly patients undergoing spinal anesthesia. The success of methods and the factors that may cause loss of temperature were examined.*
Results: *The incidence of hypothermia in geriatric patients was found to be 46 percent. One-third of hypothermic cases were seen in surgeries lasting less than one hour. External auditory canal measurements using an infrared method were correlated with thermocouple measurements. However, axillary skin temperature measurements were significantly erroneous. Low hemoglobin values were related to loss of temperature.*
Conclusion: *Old age is a special situation contributiing to hypothermia and creating a vulnerable population in terms of its results. In cases where the core temperature cannot be measured, infrared measurements of the external auditory canal can be used. Axillary skin temperature is misleading but may at least contribute to the information. But a measurement that has not been done is still the worst. With the most appropriate technique within the possibilities available, temperature monitoring should be used regardless of the operation time in geriatric patients. Because undiagnosed hypothermia cannot be treated.*

Keywords: *geriatrics, spinal anesthesia, hypothermia, intraoperative monitoring*

ÖZ

Amaç: *Spinal anestezi altındaki hastalarda sıcaklık monitörizasyonunun kullanımı beklenenden daha azdır. Ayrıca, uyanık hastalarda sıcaklık izleminin en pratik olarak nasıl ve nereden yapılması gerektiği tartışmaya açıktır. Bu çalışmada spinal anestezi altında geriatrik hastalarda hipotermi insidansını araştırdık ve sıcaklık ölçüm yöntemlerini karşılaştırdık.*
Yöntem: *Spinal anestezi uygulanan yaşlı hastalarda ameliyat öncesi ve sonrası sıcaklık izlemleri üç farklı ölçüm yöntemi kullanılarak karşılaştırıldı. Yöntemlerin başarısı ve sıcaklık kaybına neden olabilecek faktörler incelendi.*
Bulgular: *Geriatrik hastalarda hipotermi insidansı% 46 olarak bulundu. Hipotermik vakaların üçte biri 1 saatten kısa süren operasyonlarda görüldü. Infrared yöntem ile dış kulak yolu ölçümleri termokupl ölçümleri ile korele idi. Bununla birlikte, aksiller cilt sıcaklığı ölçümleri önemli ölçüde yanlıştı. Düşük hemoglobin değeri sıcaklık kaybıyla ilişkiliydi.*
Sonuç: *Yaşlılık, hipotermiye katkıda bulunan ve sonuçları açısından hassas bir populasyon yaratan özel bir durumdur. Core sıcaklığının ölçülemediği durumlarda, dış kulak yolunun infrared yöntem ile ölçümleri kullanılabilir. Aksiller cilt sıcaklığı yanıltıcıdır, ama en azından fikir sahibi olmaya katkıda bulunabilir. Ancak henüz yapılmayan bir ölçüm en kötüsüdür. Mevcut olasılıklar dahilinde en uygun teknikle, geriatrik hastalarda ameliyat süresine bakılmaksızın sıcaklık monitörizasyonu kullanılmalıdır. Çünkü teşhis edilmemiş hipotermi tedavi edilemez.*

Anahtar kelimeler: *geriatri, spinal anestezi, hipotermi, intraoperatif monitörizasyon*

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INTRODUCTION

Unintended perioperative hypothermia is defined as a fall in the patient's core temperature below 36°C. Hypothermia is frequently observed in patients whose surgery lasted for a long time under general anesthesia without the application of any heating methods [(1)]. The known complications include increased incidence of wound site infection, perioperative bleeding, delayed recovery from anesthesia, prolonged hospital stay, increased mortality and morbidity rates and higher cost [(2)]. Even in mild hypothermia, the risk of cardiac complications is increased [(3)]. Redistribution is the most effective mechanism in heat loss and vasodilation caused by spinal anesthesia (SA) leading to increased redistribution of anesthetic material [(4)].

Thermoregulation by vasoconstriction and shivering is less effective in the elderly, both in the presence and absence of anesthesia [(1)]. Decreased adipose tissue and sometimes decreased levels of communication to express the perception of feeling cold also contribute to the development of hypothermia, Based on these reasons, both national and international guidelines emphasize that geriatric patients are at greater risk of hypothermia [(5-7)]. It is now an indisputable issue that it is necessary to monitor the perioperative temperature in these patients. But the question is how to do it. According to the studies performed so far, thermocouple core temperature measurement has been the most appropriate and true method for perioperative temperature monitoring in patients undergoing surgery [(4)]. However, using the thermocouple method under spinal anesthesia can be difficult for the awake patient. Temperature monitoring with skin temperature measurement is practical for the awake patient, but it may differ from the core temperature. Therefore, skin temperature measurement can only be used for informational purposes.

Our study aimed to determine the incidence of hypothermia in geriatric patients under spinal anesthesia and compare the success of different measurement methods.

MATERIAL and METHOD

Ethical approval for this study was obtained from the local ethics committee (decision number; 2017-KAEK- 189_2019.03.13_03). One hundred and twenty patients over 65 years of age who underwent orthopedic surgery under SA were included in this study. Patients with American Society of Anesthesiologists Classification (ASA) status of 1-3 were included in the study . On the other hand; preoperative fever (38°C), thyroid disorders, autonomic neuropathy, peripheral vascular diseases, uncontrolled hypertension, vasoactive drug use, contraindications for spinal anesthesia and the patient's refusal to participate in the study were determined as exclusion criteria. In cases where we have to switch to general anesthesia (GA) during the operation were not included in the study.

Study protocol

The ambient temperature of the operating room was kept constant, between 20-22°C. Patients with a measured body temperature above 36°C in the preoperative waiting room were taken to the operation room. Preoperative heart rate, preoperative systolic arterial blood pressure values of the patients were recorded for the study after standard anesthesia monitoring and a 5- minute rest. Demographic data such as age, gender, body mass index (BMI), comorbidities and hemoglobin values obtained using standard pre-anesthesia tests were recorded. SA was performed with 10-15 mg of hyperbaric bupivacaine (Marcaine Spinal Heavy %0.5, Zentiva, Kırklareli) injected targeting the T10 level. After standard anesthesia monitoring, patients were treated with Ringer's lactate solution at 37°C at an initial IV infusion rate of 100 ml/hr, then infusion rate was adjusted, and maintained in consideration of their fluid, and electrolyte losses.

A soft tip thermocouple probe (M1024247 General purpose probe GE, USA) was inserted into the right auditory canal and secured with cotton and a bandage. The patient's core temperature was measured from the tympanic membrane using this thermocouple probe. An infrared thermometer was used to measure the tympanic membrane temperature of the left ear. At the same time, the axillary skin temperature was also measured and recorded using the same infrared thermometer (Thermoscan 5-IRT6020; Braun, Hessen, Germany).

The first minute after spinal anesthesia was considered to be time zero recorded as T1. The final measurement taken in the operation room was recorded as T2. Besides, the patients' heart rate, oxygen saturation, and blood pressure values were recorded with noninvasive monitoring methods during the study. The ambient temperature, duration of surgery, fluids applied, transfused blood units in milliliters, estimated blood loss and preoperative hemoglobin values also recorded as predictors of hypothermia. Measurement of the temperature of the tympanic membrane with a thermocouple probe is one of our measurement methods, and accepted as the actual core temperature value in this study. Classification and comparison of hypothermic (Group H) and normothermic (Group N) patients were made according to this value. Patients with a core temperature below 36 degrees were defined as hypothermic. Preoperative and postoperative temperature measurements, reasons for temperature loss were compared, and the concordance between the three different measurements was determined.

Statistical analysis

According to the power analysis made based on the previous study on the subject; it was deemed appropriate to take at least 50 patients with 0.8 power and 0.5 alpha ratio to determine the incidence of hypothermia in geriatric patients [8]. The data were analyzed using the IBM SPSS Statistics for Windows, version 18 package program (SPSS IBM Inc., Chicago, IL, USA). Data with a normal distribution were presented as the mean±standard deviation. The conformity of data to a normal distribution was assessed using the Kolmogorov-Smirnov test. The independent samples t-test was used to analyze normally distributed quantitative data. The chi-square (χ^2) test was used to analyze qualitative data. A p-value of <0.05 was accepted as statistically significant.

RESULTS

A total of 113 patients were included in our study. The mean age of the participants was 73.15±5.87 (min-max; 65-87) years. Three patients who required GA during surgery were excluded from the study. Other three patients were excluded because the first temperature measurement was not within the target temperature range (36-38 degrees). Also, one patient was unable to complete the study because she was disturbed by the temperature probe in her ear during the operation.

In normothermic patients, preoperative hemoglobin value was higher (p<0.001), the amount of bleeding (p=0.001) and the number of blood products infused were significantly less (p=0.003). There was no difference between the groups regarding the amount of fluid administered, BMI, and age. Operation times of hypothermic and normothermic patients were similar. A comparison of hypothermic and normothermic patients is presented in Table 1.

The temperatures before and after the operation were measured in three different ways. A total of 52 patients (46%) were found to be hypothermic based on the measurement of tympanic temperature using a thermocouple probe at the end of the operation, while the infrared tympanic temperature measurement identified hypothermia in 59 patients (52%). There was no difference between the two measurements in detecting hypothermia (p=0.458). Seventy

Table 1. Comparison of hypothermic and normothermic patients.

Parameters	Group H (n=52)	Group N (n=61)	p
Age (years)	74.49±5.77	71.59±5.66	0.593
BMI	28.73±3.96	26.93±3.05	0.229
Operation time (min)	82.57±34.47	79.78±37.43	0.90
Estimated blood loss (ml)	187.70±247.59	143.26±132.85	0.001
Blood products (ml)	35.24±98.88	11.53±61.52	0.003
IV fluids (ml)	1103.27 ±459.51	1049.03 ±365.21	0.70
Preoperative hemoglobin (g/dl)	12.10±1.19	13.13±1.86	<0.001
Preoperative Heart rate (bpm)	81.73±13.18	81.90±13.99	0.804
Preoperative systolic arterial pressure (mmHg)	130.44±15.93	122.09±13.74	0.134

** BMI; body mass index, IV fluids; total IV fluids administered during surgery;*
Statistical analysis was performed by independent samples t-test. Data are presented as mean ± standard deviation.

Table 2. Comparison of measurement techniques.

	Tcore (T1-T2)	T tympanic (T1-T2)	T axillary (T1-T2)	p
Temperature loss (degree)	0.76±0.61[a]	0.71±0.64[b]	1.03±0.92	<0.05
Hypothermic patients (n)	52[a]	59	70	<0.05*

Tcore, the difference between preoperative and postoperative core temperature
T tympanic, the difference between preoperative and postoperative tympanic membrane temperature
Taxillary, the difference between preoperative and postoperative axillary skin temperature.
[a] Tcore was significantly lower compared to Taxillary
[b] T tympanic was significantly lower compared to Taxillary.
*Statistical analysis was performed by independent samples t-test and *chi-square test.*

patients (61%) were found to be hypothermic according to the axillary temperature measurements, but this number of hypothermic patients was incorrectly high (p=0.027; Table 2). Considering the temperature losses according to the different measurement techniques; the decrease in temperature detected by the measurement with a thermocouple probe was similar to that of the tympanic temperature measurement using an infrared sensor (p=0.854). However, the magnitude of temperature loss according to the axillary measurement was significantly different from the measurement using a thermocouple probe (p=0.007) and tympanic temperature measurement wtih an infrared sensor (p=0.004; Table 2).

In eight of the 55 hypothermic patients (15.3 %), the operation time was less than 30 minutes, and in 10 hypothermic patients (19.2 %) the operation time was between 30 minutes and 1 hour. Therefore, in one-third (18/55, 32 %).of the hypothermic patients, the operation time was less than one hour.

DISCUSSION

Geriatric patients are more tend to the development of hypothermia due to decreased heat production, decreased muscle mass and adipose tissue, and inefficient autonomic vasodilatory and vasoconstrictory responses. Furthermore, even mild hypothermia causes an increase in risks of complication, especially cardiac complications in elderly patients [9].

According to a study examining the risk factors for the development of hypothermia, the riskiest patient groups were determined as those operated at low operating room temperature, newborns, burn patients, and those operated under a combination of GA and SA [1].

The first and the most important phase in the development of hypothermia is redistribution [4]. In a study that compared patients receiving GA and those receiving GA combined with regional anesthesia, it was found that regional anesthesia had a great effect on the redistribution phase and increased heat loss [10].

Turkish, European and American anesthesia associations recommend perioperative routine temperature monitoring. Particularly, for newborns and elderly patients temperature monitoring should be performed regardless of the duration of the operation [5,6]. However, studies have shown that the rate of heat monitoring are rarely performed in surgeries realized under regional anesthesia. Frank et al. reported a rate of 33% for these surgeries, while rates of 27% were reported in a study by Arkilic et al. and in a study of obstetric patients in the UK [11-13]. Limited access to the measurement sites in awake patients and work intensity were revealed to be the reasons for this low monitoring rate [12].

The pulmonary artery, tympanic membrane, nasopharynx, rectum and urinary bladder are appropriate sites for core temperature monitoring [11]. The most accessible of these areas for core temperature measurement in awake patients under SA is tympanic membrane approached through external auditory canal However, the measurement must be performed with an appropriate technique, as infrared temperature readings may not produce accurate results [10]. For an adequate measurement, thermocouple thermometers or thermistors should be used. This type of measurement device should be counted as one of the standard anesthesia monitoring tools and used routinely. However, the appropriate measuring device may not be available in all operating rooms. A more striking situation; the question of

where to place this temperature probe on the awake patient, poses a problem. Sessler et al. [10] inserted cotton wrapped probe into the external auditory canal and fixed with a bandage. In our study, this method was applied. One patient wanted to leave the study because she was uncomfortable with the heat probe used in this way. This factor makes performing the measurement difficult and therefore restricts routine temperature monitoring [11].

If the appropriate measurement areas for the measurement of the core temperature cannot be found, or if there is not enough equipment, the tympanic membrane appears to be superior to the axillary skin for temperature monitoring. However, it is important to know the appropriate measurement technique for both core temperature measurements and skin temperature measurement [10].

In our study, the mean temperature loss and hypothermia rates were not significantly different between infrared and thermocouple measurements of the tympanic membrane. Axillary skin temperature measurement was ineffective for detecting hypothermia in geriatric patients which may be due to the fact that axillary skin temperature is affected by many factors, including ambient temperature. According to our results, infrared tympanic temperature measurement can be used to predict hypothermia in patients for whom core temperature cannot be measured with thermocouple or thermistors, or when there are no other acceptable measurement sites.

When the overall study group is considered, 46% of patients developed hypothermia, which is very high. This is consistent with a study by Arkilic et al. [12], who reported an even higher rate of 77 percent. One of our study aims was to determine the incidence of hypothermia in geriatric patients. However, it may also be important to determine the incidence in our younger patients who were operated under spinal anesthesia in the same period. This subject may be a limitation of our study or it may be a new study subject.

Frank et al. [11] have shown that the risk and magnitude of hypothermia increases in proportion to age in patients under regional anesthesia. In this case, temperature monitoring becomes more important in the elderly. Even in our patients who were all over 65 years of age, the temperature loss increased with age. The temperature of the operating room, the patient's body mass index, block-level, blood loss, and fluid therapy may affect temperature loss, in addition to the age [14].

In our study, we tried to keep the block level standard and block-level did not rise in any patient .The ambient temperature in the operating room was maintained at the same level. BMI, the amount of fluid given did not differ between patient groups. Preoperative hemoglobin values were higher in normothermic patients, the amount of bleeding and the number of blood products administered were lower.

An important finding of our study was there was no significant difference in duration of operation between hypothermic and normothermic patients, and hypothermia has seen in short-term operations too. This fact emphasizes the effect and importance of redistribution, which occurs in the first half-hour of the operation, in the development of hypothermia in patients under SA. To emphasize again; hypothermia was observed in 46% of geriatric patients under SA and in one-third of the hypothermic patients, the operation time was less than one hour (18/55, 32%).

Considering the low rate of temperature monitoring shown in studies, the diagnosis of hypothermia is often overlooked, which means that treatment cannot be performed without making a diagnosis [2,4]. It is important to note that geriatric patients are sensitive to the negative effects of hypothermia, and even mild hypothermia increases the complication rate.

Conclusion

The risk of hypothermia is high in geriatric patients under SA. However, hypothermia cannot be diagnosed unless temperature monitoring is performed. Therefore, more attention should be paid to temperature monitoring. Infrared temperature measurements of the tympanic membrane can be used for perioperative temperature monitoring if core temperature monitoring cannot be performed.

Ethics Commitee Approval: For this study ethics committee approval was received from the local ethics committee of Yozgat Bozok University Faculty of Medicine. (decision number; 2017-KAEK-189_2019.03.13_03).

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REFERENCES

1. Macario A, Dexter F. What are the most important risk factors for a patient's developing intraoperative hypothermia? Anesth Analg. 2002;94(1):215-20. https://doi.org/10.1213/00000539-200201000-00042
2. Allen TK, Habib AS. Inadvertent perioperative hypothermia induced by spinal anesthesia for cesarean delivery might be more significant than we think: are we doing enough to warm our parturients? Anesth Analg. 2018;126(1):7-9. https://doi.org/10.1213/ANE.0000000000002604
3. Díaz M, Becker DE. Thermoregulation: physiological and clinical considerations during sedation and general anesthesia. Anesth Prog. 2010;57(1):25-32; quiz 33-4. https://doi.org/10.2344/0003-3006-57.1.25
4. Sessler DI. Perioperative thermoregulation. Geriatr Anesthesiol. 2016;6736(15):107-22. https://doi.org/10.1007/978-0-387-72527-7_8
5. Turkish Society of Anaesthesiology and Reanimation (TSAR). Practice Guideline for Prevention of Unintentional Perioperative Hypothermia. Turk J Anaesthesiol Reanim. 2013;41:188-90. https://doi.org/10.5152/TJAR.2013.64
6. National Institute for Care and Health Excellence. Hypothermia: prevention and management in adults having surgery-clinical guideline [CG65]. 2008;April 2008:1-18. Available from: https://www.nice.org.uk/guidance/cg65. (accessed on 01.12.2019)
7. American Society Of Anesthesiologists. Standards for basic anesthetic monitoring. 2015. Available from: https://www.asahq.org/standards-and-guidelines/standards-for-basic-anesthetic-monitoring (accessed on 31.03.2020).
8. Emmert A, Gries G, Wand S, et al. Association between perioperative hypothermia and patient outcomes after thoracic surgery: A single center retrospective analysis. Medicine (Baltimore). 2018;97(17):e0528. https://doi.org/10.1097/MD.0000000000010528
9. Connor EL, Wren KR. Detrimental effects of hypothermia: a systems analysis. J Perianesth Nurs. 2000;15(3):151-5. https://doi.org/10.1053/jpan.2000.7508
10. Sessler D. Temperature monitoring and perioperative thermoregulation. Anesthesiology. 2008;109(2):318-38. https://doi.org/10.1097/ALN.0b013e31817f6d76
11. Frank SM, Nguyen JM, Garcia CM, Barnes RA. Temperature monitoring practices during regional anesthesia. Anesth Analg. 1999;88(2):373-7. https://doi.org/10.1097/00000539-199902000-00028
12. Arkiliç CF, Akça O, Taguchi A, Sessler DI, Kurz A. Temperature monitoring and management during neuraxial anesthesia: an observational study. Anesth Analg. 2000;91(3):662-6. https://doi.org/10.1213/00000539-200009000-00031
13. Aluri S, Wrench IJ. Enhanced recovery from obstetric surgery: a UK survey of practice. Int J Obstet Anesth. 2014;23(2):157-60. https://doi.org/10.1016/j.ijoa.2013.11.006
14. Frank SM, El-Rahmany HK, Cattaneo CG BR. Predictors of hypothermia during spinal anesthesia. Anesthesiology. 2000;92(5):1330-4. https://doi.org/10.1097/00000542-199809200-00054