





**FULL PAPER**

# Studying the effects of chemical shivering in diabetic and non-diabetic patients after orthopedic surgery

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Diabetic patients may present different reactions to chemical postoperative shivering. The current study aimed to compare the rate of chemical shivering after orthopedic surgery in diabetic and non-diabetic patients. In this study, 567 patients were scheduled for elective orthopedic surgery who were selected using the census method. Participants were separated into two groups of diabetic and non-diabetic patients. Chemical shivering intensity in the recovery unit was measured using the Nekasuchi System and compared between both groups. In total, 108 (19.41%) patients presented chemical postoperative shivering (13 (12.03%) diabetic and 95 (87.97%) non-diabetic patients). Chemical shivering was significantly higher in non-diabetic patients ( $P=0.001$ ). Diabetes causes a decreased prevalence of chemical postoperative shivering so that non-diabetic patients are more susceptible to postoperative shivering than diabetic patients.

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**KEYWORDS**

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**Introduction**

During the postoperative period, the unintended hypothermia has several complications, one of the most important of which is post-anesthesia shivering (PAS). While its etiology is not identified yet, it has a high prevalence, ranging from 40 to 60% in patients who received inhaled anesthesia. In awake people, behavioral mechanisms are much more powerful than the autonomic system in regulating body temperature when the body is exposed to cold; however, autonomic control is much more accurate [1,2].

Anesthesia suspends the necessary mechanisms for preventing physiological disorders related to the temperature regulation. Despite the introduction of

various drugs to alleviate this side effect, it continues to be a significant issue in the postoperative period. Shivering is an involuntary, oscillating muscular activity which intensifies heat production through the metabolic process up to 600 percent above the baseline level [3,4]. Shivering increases oxygen consumption and carbon dioxide production by twice to three times. Pain and stress of surgery increase the risk of shivering-like tremors in the postoperative period. Since shivering is a constant complication associated with anesthesia and surgery, fundamental attention should be paid to its prevention and treatment [5].

There is still no consensus regarding the etiology of postoperative shivering, but young age, low core body temperature, uncontrolled spinal reflexes, pain, the release of febrile

mediating substances, and respiratory alkalosis are reported as the etiological risk factors. Shivering is a tremor motor function, which is defined as rhythmic muscle contractions with a frequency of 4 to 8 Hz. It's mainly due to the hypothermia caused by surgery or fluid therapy during surgery; however, its real cause is not clear yet, but mainly is due to the hypothermia caused by a disturbance in thermoregulation resulted from anesthetic drugs. All mammals have spinal thermal receptors, which *in vitro* stimulation of these receptors in animals have caused shivering; in humans, stimulating these receptors causes thermoregulation response and shivering. It seems that diabetes influences these receptors, which prevents shivering. However, further investigations are needed.

Diabetes is a common disease which increases the surgery risk. Besides, its complications are a great concern for physicians. One of these complications is Cardiac *Autonomic Neuropathy* (CAN), which its prevalence ranges from one to 90%. In diabetic patients, the natural response stimulated by vascular contraction and tachycardia due to the vasodilatory effects of anesthesia cannot be ceased. There is an association between CAN and intraoperative hypothermia [6,7].

PAS is a common phenomenon which can cause complications in patients with specific diseases. Besides, most of previous studies have focused on treating this health condition and the effects of different therapeutic interventions (both pharmaceutical and non-pharmaceutical) as well as preventing the consequences. Our review revealed that none of the previously conducted studies have investigated the confounding role of comorbidities. On the other hand, diabetes is a disease with various complications, particularly neuropathy. Therefore, they may present various responses to postoperative shivering; in this line, in the present study, we aimed to compare the rate of postoperative

shivering in diabetic and non-diabetic patients. According to the best knowledge of the authors, this is the first study of its kind.

## Methods

### *Study design*

This prospective descriptive-analytical study was conducted in an orthopedic hospital in Iran in 2018. The sample size was calculated based on the Morgan Table, a confidence level of 95% and an acceptable error of 5%, which yielded a sample size of 384 subjects. In order to increase the accuracy of the findings, participants were selected using the census method.

### *Inclusion and exclusion criteria*

Inclusion criteria were: (1) being a candidate for elective orthopedic surgery, (2) spinal anesthesia, and (3) diabetes diagnosis. Exclusion criteria were: (1) having thyroid diseases, (2) having fever or hypothermia, (3) patients with a high probability of blood transfusion, (4) patients with emergency conditions, and (5) patients with opioid addiction.

### *Implementation*

In this study, patients undergoing elective orthopedic surgery were studied after applying inclusion and exclusion criteria. At first, patients were physically examined by an anesthesiologist the day before surgery. Then, the duration of diabetes, its type, and treatments, as well as its possible complications were recorded in a checklist for each individual. Patients with an acceptable index for spinal anesthesia were enrolled in the study. It is worth noting that only patients with a blood glucose of <180 were included. The patients were then divided into two groups of diabetic and non-diabetic as case and control groups. After entering the operating room and performing basic monitoring, including heart rate,

electrocardiography, body auxiliary temperature, arterial oxygen saturation, systolic, and diastolic blood pressure were measured using non-invasive methods. Then, 500 cc of normal saline serum was intravenously administered for half an hour. Afterward, spinal anesthesia was performed. Before spinal anesthesia and then, every hour during surgery, the blood glucose level of patients was measured and recorded in a checklist. The variables included shivering, age, and gender. The intensity of shivering was measured using the Nekasuchi System and scored as follow: grade zero (without shivering), grade one (one or two areas with hair skewering, without visible muscle activity), grade two (visible muscle activity in some muscles), grade three (similar to grade two, but in more than one muscle groups), grade four (intense muscle activity in the whole body).

#### *Ethical considerations*

The informed written consent was obtained from all participants. All costs were covered by the fund provided for the study. The data were also collected anonymously. Ethic No. is IR.TBZMED.REC.1398.593.

#### *Statistical significance*

The data were analyzed using SPSS version 22. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used for statistical analysis. To compare the qualitative findings, the chi-square test was used. Likewise, to compare quantitative findings between the groups, ANOVA, Kruskal-Wallis non-parametric test, and t-test were used. Statistical significance was considered when p-value was  $<0.05$ .

## **Results**

In this study, 567 patients scheduled for orthopedic surgery were studied with spinal

anesthesia, among whom 294 (51.90%) were diabetic, and 273 (48.10%) were healthy. Among diabetic patients, 273 (92.81%) had type 2 diabetes, and 19 (7.19) had type 1 diabetes. The mean age of diabetic patients was  $67.74 \pm 14.46$  years, and for non-diabetic patients, it was  $47.19 \pm 86.68$ . Hence, diabetic patients were significantly older ( $P=0.001$ ). Of 567 patients, 301 (53.1%) were male. Concerning diabetic patients, 114 (48%) were male, and 153 were female. Concerning non-diabetic patients, 160 (58.6%) were male and 113 (41.4%) were female. Therefore, diabetes was significantly more prevalent among females ( $P=0.007$ ). The mean duration of diabetes diagnosis was  $44.29 \pm 9.5$  years; also, 244 patients were consuming metformin, with a mean daily consumption of  $1.0 \pm 99.69$ ; and for four patients, it was  $2.0 \pm 25.51$ .

The mean and standard deviation of blood glucose levels on the morning of surgery, immediately before surgery, and an hour after initiating surgery were  $164 \pm 11.84$ ,  $151.33 \pm 53.01$ , and  $141.17 \pm 45.73$ , respectively. In 92 patients, the surgery lasted between one and two hours, and the mean blood glucose was  $148.28 \pm 38.19$ . In 40 patients, the surgery lasted for two to three hours, and the mean blood glucose was  $44.82 \pm 30.144$ . Finally, 108 patients (19.41%) presented postoperative shivering (13 (12.03%) diabetic patients and 95 (87.97%) non-diabetic patients). Shivering was significantly higher in non-diabetic patients ( $P=0.001$ ) (Table 1).

Also, 78 patients (72.2%) were treated with pethidine injections due to shivering. Also, in 30 patients, the shivering was removed without medication. There was no significant difference between diabetic and non-diabetic patients concerning this issue ( $P=0.41$ ) (Table 2).

**TABLE 1** Comparison of shivering prevalence and its degree between diabetic and non-diabetic patients

Variable		Diabetic	Non-Diabetic	P Value
Shivering	Yes	13(4/4%)	95(34/8%)	0/001
	No	281(95/6%)	175(65/2%)	
Shivering Grade	I	4(30/8%)	17(17/9%)	0/5
	II	6(42/2%)	39(41/1%)	
	III	3(23/1%)	37(38/9%)	
	IV	0(0%)	2(1/9%)	

**TABLE 2** Comparison of response to treatment with pethidine in diabetic and non-diabetic groups

Response rate to treatment	Diabetic	Non-Diabetic	P Value
Good	8(100%)	57(81/4%)	0/41
Medium	0(0%)	11(15/7%)	
Weak	0(0%)	2(2/9%)	

## Discussion

The current study aimed to compare the rate of shivering after orthopedic surgery in diabetic and non-diabetic patients. The results indicated that the shivering incidence after elective orthopedic surgery in diabetic and non-diabetic patients was 4% and 34%, respectively, which was significantly higher in non-diabetic patients. A study [8] also reported similar results. They reported that the incidence of shivering was lower in patients with diabetic autonomic neuropathy than in healthy patients. Likewise, In the Other Study [9] reported that taking drugs such as calcium antagonists, diuretics, H pump blockers, and oral diabetes-controlling drugs was associated with significantly reduced incidence of postoperative shivering, which is consistent with the findings of the present study.

The findings of the present study indicated that postoperative shivering in diabetic and non-diabetic patients was well controlled by injecting pethidine. In this regard, researcher [10] reported that in the pethidine group, 84% of shivering recoveries were observed up to 150 seconds after injection. Researcher in the other study [4] also found similar results. They reported that 8% of patients

presented shivering, which was associated with hypothermia. Pethidine was also more effective in treating shivering. Researcher in a study [11], also found that pethidine could reduce and eliminate postoperative shivering.

## Conclusion

Diabetes reduces postoperative shivering, and non-diabetic individuals who are more susceptible to postoperative shivering. The authors recommend addressing the limitations of the present study in future research. Likewise, multi-center studies can present more generalizable findings. Physiological studies are also recommended to investigate the effects of diabetes on neurons and shivering receptors. The current study had limitations including not considering the type of surgery, not considering the operating room temperature, not considering the temperature of received serum during anesthesia, and not paying attention to preoperative stress.

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