



Postoperative hypothermia in geriatric patients undergoing arthroscopic shoulder surgery

Eun Hee Chun, Guie Yong Lee, and Chi Hyo Kim

Department of Anesthesiology and Pain Medicine, Ewha Womans University College of Medicine, Seoul, Korea

Received May 18, 2018

Revised 1st, July 12, 2018

2nd, August 4, 2018

Accepted August 6, 2018

Corresponding author

Guie Yong Lee, M.D., Ph.D.
Department of Anesthesiology
and Pain Medicine, Ewha Womans
University College of Medicine, 1071
Anyangcheon-ro, Yangcheon-gu,
Seoul 07985, Korea
Tel: 82-2-2650-5285
Fax: 82-2-2652-2924
E-mail: lgyanes@ewha.ac.kr

ORCID

<https://orcid.org/0000-0001-8208-7506>

Background: Hypothermia below 36°C is a common problem during arthroscopic shoulder surgery. Geriatric patients are more vulnerable to perioperative hypothermia. The present study compared postoperative hypothermia between geriatric and young adult patients receiving arthroscopic shoulder surgery.

Methods: Data were collected retrospectively from a geriatric group (aged 65 or more, n = 29), and a control group (aged 19–64, n = 33) using the anesthesia records of patients who had undergone arthroscopic shoulder surgery. The primary outcome measure was the incidence of hypothermia upon arrival in the postanesthesia care unit (PACU). The secondary outcome measure was the decrease in body temperature from admission into the operating room to admission into the PACU.

Results: The incidence of hypothermia was 93.1% and 54.5% in the geriatric and control groups, respectively, demonstrating a significant difference between the groups (P < 0.001). Comparison between body temperature revealed a decrease of 1.5 ± 0.6°C and 1.0 ± 0.4°C in the geriatric and control groups, respectively, showing a significant difference between the groups (P < 0.001). The degree of hypothermia was significantly different between the groups (P = 0.027). No shivering was observed in either of the two groups, but the incidence of thermal discomfort was higher in the geriatric group than in the control group (P = 0.021).

Conclusions: In geriatric patients undergoing arthroscopic shoulder surgery, both the incidence of postoperative hypothermia and the associated temperature drop are more prominent than those in young adult patients. Additional warming methods will be needed to prevent postoperative hypothermia in geriatric patients.

Keywords: Aged; Arthroscopy; Hypothermia.

INTRODUCTION

Hypothermia, which is defined as a core temperature below 36°C, occurs in patients undergoing arthroscopic shoulder surgery as a result of heat loss due to the administration of large amounts of room temperature irrigation fluid [1–4]. Perioperative hypothermia causes problems such as morbid cardiac events [5], coagulopathy and increased transfusion requirements [6], surgical wound infections [7], and pro-

longed postoperative recovery [8].

Geriatric patients have a higher risk of intraoperative and postoperative hypothermia because they are less able to control their body temperature [9,10]. As the human lifespan continues to increase, the number of geriatric patients who undergo shoulder arthroscopy for rotator cuff and acromial pathology resulting from age-wear phenomena is also increasing. However, there are no reports on decreases of body temperature in geriatric patients undergoing arthroscopic

shoulder surgery.

The aim of the present study was to compare postoperative hypothermia between geriatric and young adult patients receiving arthroscopic shoulder surgery.

MATERIALS AND METHODS

Following approval from the Institutional Review Board (EUMC 2017-05-002), retrospective analysis was performed, using anesthesia records, of changes in body temperature during surgery and in the postanesthesia care unit (PACU) in patients who had undergone arthroscopic shoulder surgery between January 2017 and June 2017. One hundred twenty-one patients were initially enrolled, but 59 patients for whom insufficient records regarding body temperature in the operating room and the PACU were available were subsequently excluded.

All patients underwent interscalene brachial plexus block (ISBPB) using ropivacaine with ultrasound guidance for postoperative pain control prior to general anesthesia, according to the protocol for the arthroscopic shoulder surgery. General anesthesia was induced with propofol, fentanyl, and rocuronium. After endotracheal intubation, anesthesia was maintained with sevoflurane or desflurane and a 50% nitrous oxide in oxygen mixture. All patients were covered with a forced-air warming device (Bair Hugger™ Model 505 Warming System, Arizant Healthcare Inc., USA) from the level of the xiphoid process to the foot according to the protocol for the arthroscopic shoulder surgery. The forced-air warming device was set at 43°C after the induction of anesthesia and maintained throughout the operation. Cases in which other warming devices were used (humidified and heated respira-

tory circuit, heated pad, intravenous fluid warmer, etc.) were excluded from the analysis.

The 62 patients were divided according to age into a geriatric group (n = 29) including patients aged 65 or more and a control group (n = 33) containing patients aged between 19 and 65. Demographic and clinical variables, such as age, height, weight, duration of anesthesia and operation, and amount of irrigation fluid used during surgery were analyzed in both groups. Patient body temperatures used in the present study were the values measured using a tympanic thermometer at the time points before anesthesia induction and in the PACU, and the values measured with an esophageal thermometer during surgery. The body temperature values investigated were the measurements upon admission into the operating room, after anesthetic induction, at 30 minutes and 60 minutes after general anesthesia, on completion of surgery, upon arrival in the PACU, and 30 minutes after arrival in the PACU.

The primary outcome measure for this study was the incidence of hypothermia upon arrival in the PACU. The secondary outcome measure was the decrease in body temperature from admission into the operating room to admission into the PACU. In addition, the degree of hypothermia (mild: 35.5–35.9°C, moderate: 35.0–35.4°C, and severe: 34.5–34.9°C), and the incidence of shivering and thermal discomfort in the PACU were evaluated.

In statistical analysis, an independent t-test with the continuous variables, a χ^2 -test or Fisher's exact test with the categorical variables, and a repeated measures analysis of variance (ANOVA) with a Bonferroni's correction with the difference in body temperature between the two groups were performed. A P value < 0.05 was considered significant.

Table 1. Patient Characteristics and Perioperative Clinical Data

Variables	Geriatric group (n = 29)	Control group (n = 33)	P value
Age (yr)	71.5 ± 5.6	47.1 ± 14.2	< 0.001
Sex (M/F)	10/19	23/10	0.006
Weight (kg)	58.9 ± 9.0	68.8 ± 11.1	< 0.001
Height (cm)	156.4 ± 9.3	167.7 ± 8.7	< 0.001
Duration of anesthesia (min)	117.4 ± 21.0	119.1 ± 27.4	0.723
Duration of surgery (min)	66.0 ± 16.5	68.5 ± 25.2	0.688
Irrigation fluid (L)	24.7 ± 10.7	21.3 ± 10.1	0.692
BT on arrival in OR (°C)	36.8 ± 0.3	36.7 ± 0.4	0.647
BT on arrival in PACU (°C)	35.3 ± 0.5	35.8 ± 0.4	< 0.001

Data are expressed as number of patients or mean ± SD. BT: body temperature, OR: operating room, PACU: postanesthesia care unit.

RESULTS

Table 1 summarizes the demographic and perioperative clinical data of the two groups. The duration of surgery and amount of irrigation fluid used were similar in the two groups, except age, weight and height. At the time of admission into the operating room, the baseline body temperatures in the geriatric and control groups were $36.8 \pm 0.3^\circ\text{C}$ and $36.7 \pm 0.4^\circ\text{C}$, respectively, with no significant difference between the groups. The body temperatures in the geriatric and control groups upon arrival at the PACU were $35.3 \pm 0.5^\circ\text{C}$ and $35.8 \pm 0.4^\circ\text{C}$, respectively, with a significant difference between the groups ($P < 0.001$). The incidence of hypothermia below 36°C upon arrival at the PACU was 93.1% and 54.5% in the geriatric and control group, respectively, demonstrating a significant difference between the two groups ($P < 0.001$).

Comparison between body temperature at the time of admission to the operating room and the time of entry into the PACU revealed a decrease of $1.5 \pm 0.6^\circ\text{C}$ and $1.0 \pm 0.4^\circ\text{C}$ in the geriatric and control groups, respectively, showing a significant difference between the groups ($P < 0.001$). The degree of hypothermia was significantly different between the groups ($P = 0.027$); severe hypothermia ($< 35^\circ\text{C}$) was observed in 37.9% of the geriatric group and 3.0% of the control group (Table 2). No shivering was observed in either of the two groups, but the incidence of thermal discomfort was higher in the geriatric group (7 out of 29, 24.1%) than in the control group (1 out of 33, 3.0%) ($P = 0.021$). Fig. 1 shows the decrease in body temperature in both groups during surgery.

Table 2. Incidence of Hypothermia in PACU and Severity of Postoperative Hypothermia

Variables	Geriatric group (n = 29)	Control group (n = 33)	P value
Normothermia	2 (6.9)	15 (45.5)	< 0.001
Hypothermia	27 (93.1)	18 (54.5)	< 0.001
Severity of hypothermia			0.027
Mild ($35.5\text{--}35.9^\circ\text{C}$)	10 (34.5)	9 (27.3)	
Moderate ($35.0\text{--}35.4^\circ\text{C}$)	6 (20.7)	8 (24.2)	
Severe ($34.5\text{--}34.9^\circ\text{C}$)	11 (37.9)	1 (3.0)	

Data are expressed as number of patients (%). PACU: postanesthesia care unit.

DISCUSSION

In the present study, geriatric patients undergoing arthroscopic shoulder surgery showed a higher incidence (93.1% vs. 54.5%, $P < 0.001$) of postoperative hypothermia as well as a greater drop in body temperature (1.5°C vs. 1.0°C , $P < 0.001$) than did young adult patients. In addition, the body temperature was decreased by 1.5°C upon arrival to the PACU compared to the temperature at the time of admission into the operating room.

Most surgical patients under general anesthesia are prone to hypothermia as a result of anesthetic-induced impairment of thermoregulatory control, as well as exposure to a cold operating room. Geriatric patients under general anesthesia experience a greater decrease in core temperature and a longer period of hypothermia owing to impaired thermoregulatory vasoconstriction [9] compared to young patients [10]. The British National Institute for Health and Care Excellence presents the following guidelines for the prevention of perioperative hypothermia. The patient's temperature should be measured before the induction of anesthesia and then every 30 minutes until the end of surgery. In addition, the ambient temperature should be kept above 21°C , warming of intravenous fluids and blood products should be performed, and a

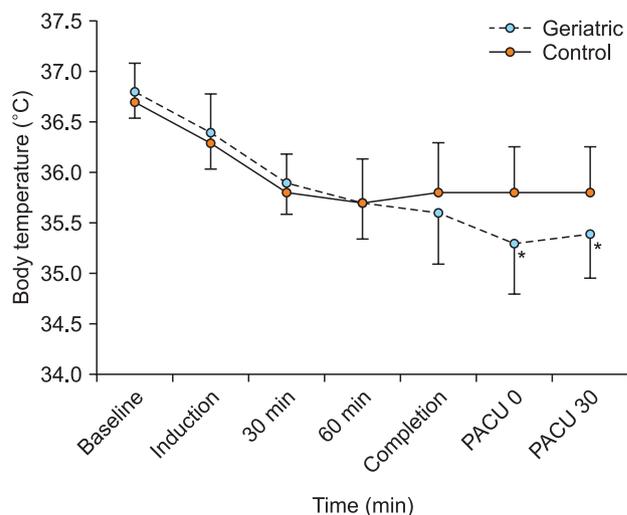


Fig. 1. Changes of mean body temperatures; Data are presented as mean \pm SD. Body temperature was significantly lower in the geriatric group on PACU 0 and PACU 30. Asterisks (*) represent significant difference between the groups ($P < 0.05$). PACU: postanesthesia care unit, PACU 0: time of arrival at PACU, PACU 30: 30 minutes after arrival at PACU.

forced-air warming device should be used if the temperature falls below 36°C [11].

Many studies examining hypothermia during arthroscopic shoulder surgery have used room temperature irrigation fluid [1–3,12] but there have been no reports describing decreases in body temperature in geriatric patients. In the present study, in which room temperature irrigation fluid was used, the amount of irrigation fluid administered was similar between the geriatric and young adult groups, but the body temperature was significantly lower in the geriatric group upon arrival in the PACU. This result is consistent with the findings reported by Kim et al. [4] in that the core body temperature is correlated with patient age (18–66 years) in cases in which room temperature irrigation fluid is used.

A forced-air warming system reduces radiative heat loss by replacing the cool operating room environment with a warm cover. In addition, a forced-air warming system may prevent decreases in body temperature by producing a flow of warm air across the skin and by allowing convection to increase heat gain [13]. On the other hand, rapid core-to-peripheral heat redistribution by anesthesia-induced vasodilation occurs in the first hour after anesthesia induction and independently with other warming methods, such as forced-air warming devices. Intraoperative forced-air warming is only effective at 60 minutes after induction during arthroscopic shoulder surgery [12]. In the present study, the mean duration of surgery was approximately 60 minutes, which appears to be too short to allow the provision of sufficient external heat by an active warming device. The more pronounced postoperative hypothermia in the geriatric group suggests that the anesthesia-induced decrease in body temperature was greater in geriatric patients, and the forced air-warming device had a smaller effect. This result indicates that an additional warming method should be employed in geriatric patients. Accordingly, pre-warming prior to surgery may prevent the decrease in core temperature through redistribution of body heat between the core and peripheral tissues [14].

In the present study, the degree of hypothermia was severe in the geriatric group, but no shivering was observed. These results support the previous findings that geriatric patients become more hypothermic during surgery [10,15] and shiver less during both spinal anesthesia [16] and after general anesthesia [17] than do younger patients.

Various methods have been investigated to prevent hy-

pothemia in patients undergoing arthroscopic shoulder surgery. Lim et al. [18] prevented intraoperative hypothermia during arthroscopic shoulder surgery by decreasing the intraoperative concentration of desflurane through preoperative ISBPB. In the present study, in which preoperative ISBPB had been performed, the incidence of hypothermia was 54.5% in the control group, lower than that observed in the control group (91.3%) in the study of Kim et al. [4]. The concentration of the inhalation anesthetic was not evaluated in the present retrospective study, but it was assumed that the ISBPB performed before general anesthesia might have had a slight effect in preventing the decrease of body temperature in both groups.

While some researchers have reported that warmed fluid irrigation during arthroscopic shoulder surgery decreased the incidence of hypothermia [1,4], a contrasting finding showed that warmed fluid irrigation failed to prevent hypothermia [3]. One study also revealed that the decrease in core temperature was not prevented using a humidified and heated respiratory circuit [2]. Although these heating methods may have different effects on geriatric patients and young adults, these methods were not used in the present study. Further research on these subjects will be beneficial for geriatric patients.

The current study has the limitations of a retrospective study. First, the operating room temperature and general anesthetics were not evaluated. The process of body temperature recovery of the geriatric patients in the PACU was not evaluated sufficiently. Second, no standard shivering and thermal discomfort criteria were set. Third, there might have been some thermal differences between the esophageal and tympanic thermometers. The infrared tympanic thermometer exhibited reliable results but reflected lower temperatures than the esophageal thermometer [19]. Lastly, a greater number of female than male patients were included in the geriatric group in the study; however, the effect of gender on the body temperature of geriatric patients was not evaluated. We hope that further studies will be performed to investigate the effect of gender on body temperature decrease during shoulder arthroscopic surgery in geriatric patients.

In conclusion, in geriatric patients undergoing arthroscopic shoulder surgery, both the incidence of postoperative hypothermia and the associated temperature drop are more prominent than those in young adult patients. Additional warming methods will be needed to prevent postoperative

hypothermia in geriatric patients during arthroscopic shoulder surgery.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Eun Hee Chun: <https://orcid.org/0000-0002-8651-0479>

Chi Hyo Kim: <https://orcid.org/0000-0002-9075-3748>

REFERENCES

- Board TN, Srinivasan MS. The effect of irrigation fluid temperature on core body temperature in arthroscopic shoulder surgery. *Arch Orthop Trauma Surg* 2008; 128: 531-3.
- Jo YY, Kim HS, Chang YJ, Yun SY, Kwak HJ. The effect of warmed inspired gases on body temperature during arthroscopic shoulder surgery under general anesthesia. *Korean J Anesthesiol* 2013; 65: 14-8.
- Oh JH, Kim JY, Chung SW, Park JS, Kim DH, Kim SH, et al. Warmed irrigation fluid does not decrease perioperative hypothermia during arthroscopic shoulder surgery. *Arthroscopy* 2014; 30: 159-64.
- Kim YS, Lee JY, Yang SC, Song JH, Koh HS, Park WK. Comparative study of the influence of room-temperature and warmed fluid irrigation on body temperature in arthroscopic shoulder surgery. *Arthroscopy* 2009; 25: 24-9.
- Frank SM, Fleisher LA, Breslow MJ, Higgins MS, Olson KF, Kelly S, et al. Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events. A randomized clinical trial. *JAMA* 1997; 277: 1127-34.
- Schmied H, Kurz A, Sessler DI, Kozek S, Reiter A. Mild hypothermia increases blood loss and transfusion requirements during total hip arthroplasty. *Lancet* 1996; 347: 289-92.
- Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. Study of wound infection and temperature group. *N Engl J Med* 1996; 334: 1209-15.
- Lenhardt R, Marker E, Goll V, Tschernich H, Kurz A, Sessler DI, et al. Mild intraoperative hypothermia prolongs postanesthetic recovery. *Anesthesiology* 1997; 87: 1318-23.
- Ozaki M, Sessler DI, Matsukawa T, Ozaki K, Atarashi K, Negishi C, et al. The threshold for thermoregulatory vasoconstriction during nitrous oxide/sevoflurane anesthesia is reduced in the elderly. *Anesth Analg* 1997; 84: 1029-33.
- Vaughan MS, Vaughan RW, Cork RC. Postoperative hypothermia in adults: relationship of age, anesthesia, and shivering to re-warming. *Anesth Analg* 1981; 60: 746-51.
- NICE. Inadvertent perioperative hypothermia. National Institute for Health and Care Excellence. 2008 Apr [updated 2016 Dec; cited 2018 Jan 12] Available from <https://pathways.nice.org.uk/pathways/inadvertent-perioperative-hypothermia>.
- Yoo HS, Park SW, Yi JW, Kwon MI, Rhee YG. The effect of forced-air warming during arthroscopic shoulder surgery with general anesthesia. *Arthroscopy* 2009; 25: 510-4.
- Sessler DI. Complications and treatment of mild hypothermia. *Anesthesiology* 2001; 95: 531-43.
- Shin KS, Lee GY, Chun EH, Kim YJ, Kim WJ. Effect of short-term prewarming on body temperature in arthroscopic shoulder surgery. *Anesth Pain Med* 2017; 12: 388-93.
- Frank SM, Beattie C, Christopherson R, Norris EJ, Rock P, Parker S, et al. Epidural versus general anesthesia, ambient operating room temperature, and patient age as predictors of inadvertent hypothermia. *Anesthesiology* 1992; 77: 252-7.
- Vassilief N, Rosencher N, Sessler DI, Conseiller C. Shivering threshold during spinal anesthesia is reduced in elderly patients. *Anesthesiology* 1995; 83: 1162-6.
- Carli F, Gabrielczyk M, Clark MM, Aber VR. An investigation of factors affecting postoperative rewarming of adult patients. *Anaesthesia* 1986; 41: 363-9.
- Lim SH, Lee W, Park J, Kim MH, Cho K, Lee JH, et al. Preoperative interscalene brachial plexus block aids in perioperative temperature management during arthroscopic shoulder surgery. *Korean J Anesthesiol* 2016; 69: 362-7.
- Poveda VB, Nascimento AS. Intraoperative body temperature control: esophageal thermometer versus infrared tympanic thermometer. *Rev Esc Enferm USP* 2016; 50: 946-52.