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Infusion of Warm Fluid During Abdominal Surgery Prevents Hypothermia and Postanaesthetic Shivering

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Abstract

BACKGROUND: Perioperative hypothermia is a frequent occurrence and can lead to several complications. The aim of this study is to evaluate the efficacy of warm fluid in maintaining normal core temperature during the intraoperative period.
METHODS: We studied 30 American Society of Anesthesiologists (ASA) physical status I or II adult patients who required general anesthesia for abdominal surgery. In control group (n=15), fluids were infused at room temperature; in test group (n=15), fluids were infused at 37 ℃. Core temperature was measured at the tympanic site. During recovery, shivering was evaluated by an independent observer.
RESULTS: The two groups did not differ significantly in patient characteristics. In control group, core temperature decreased to 35.5 ±0.3 ℃ during the first 3 hours, and then stabilized at the end of anesthesia. In test group, core temperature decreased during the first 60 min, but increased to 36.9 ±0.3 ℃ at the end of anesthesia. In control group, 8 patients shivered at grade ≥2. In test group, none of the patients reached grade ≥ 2 ($P < 0.01$).
CONCLUSIONS: Infusion of warm fluid is effective to keep patients nearly normothermic and prevent postanaesthetic shivering. It may provide an easy and effective method for perioperative hypothermia prevention.

Index Terms: Temperature, Fluid, Abdominal

1. Introduction

Hypothermia is typically defined as a core body temperature of ≤36℃ (≤96.8°F), though patient outcomes are reportedly better when a temperature of ≥36.5℃ is maintained.1 Perioperative hypothermia is frequently

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found. [1, 2] It may result from the disorganization in thermoregulation, caused by anesthesia, the type or dimension of the surgery and the surgical environment. [3] Without any positive body warming, the core temperature of patients usually decreases precipitously for first hour, then decreases slowly for the next one or two hours and finally becomes constant after the induction of general anesthesia. [4] It is reported that perioperative hypothermia could lead to severe consequences, such as the diminished blood flow in all systems, cardiac arrhythmias, increased tissular demand of oxygen, diminished metabolism, impaired platelet function, increased susceptibility to surgical wound infection, and more. [5] Furthermore, it is believed that hypothermia contributes to the development of postoperative shivering, which is a relatively frequent complication of anesthesia and surgery that can be distressing to patients and is occasionally associated with deleterious sequelae. [6]

Although the actual change of core temperature depends on many factors, such as rate of body heat generation, rate of heat loss to the outside environment; body size, ambient temperature, tissue blood flow, and temperature gradients within the body, it is reported that the administration of room-temperature intravenous (IV) fluids can produce hypothermia. [7] Gentilello LM et al. [8] estimated that 1 L of room temperature crystalloid solution decreased the mean body temperature by 0.25℃. Oppositely, it was reported that warming treatment during the surgery such as water warming garment and forced air warming was effective on preventing intraoperative hypothermia. [9] Considering the negative influence caused by room-temperature IV and the positive influence probably caused by warming treatment, we speculated that perioperative hypothermia might be improved by warming fluid treatment.

Therefore, the aim of this study was to evaluate the efficacy of warm fluid in maintaining normal core temperature and preventing postoperative shivering during the postoperative period.

2. Methods

This study was approved by Ethical Committee on Human Research of First Affiliated Hospital of Medical College of Shantou University. Informed consents were obtained from each patient.

We studied 30 ASA physical status I or II adult patients who required general anesthesia for abdominal surgery. Patients with a history of thyroid disease, dysautonomia, or malignant hyperthermia were excluded. Each patient participated on a single study day between November 2007 and February 2008.

Patients were allocated randomly to one of two groups. The two groups did not differ significantly in age, weight, height, gender, duration of anaesthesia, fluids administered and ASA class (Table 1). All patients fasted for 8 hours before the study. Clean laminar flow operation room (build by Xi'an Siteng Engineering Co., Ltd.) was used to maintain the ambient temperature at 24℃ and ambient relative humidity at 30% during the study. Each patient was fixed in the supine position and covered with unwarmed cotton blankets. During the operation, no warming equipment was used. The patients were premedicated with an oral administration of 50 mg pentobarbital 1 hour before the operation. No other premedication was given.

In control group (n=15), fluids (normal saline) were infused at room temperature; in test group (n=15), all intraoperative fluids (normal saline) were delivered via the Hotline IV fluid warmer (Smiths Medical ASD, Inc. America) at 37℃. The anaesthetic management of the patients was standardized. The anaesthesia was induced with intravenous injection (i.v.) propofol 2.5 mg/kg and fentanyl 4 μg/kg, and vecuronium 0.1 mg/kg was treated to facilitate orotracheal intubation. Anaesthesia was maintained with propofol and fentanyl. Repeat doses of vecuronium 0.03–0.05 mg/kg were given if required.

Core temperature was measured at the tympanic site. Temperature was recorded at 30-min intervals from the beginning of anaesthesia. After approximately 2 hours, general anesthesia was discontinued, and the trachea was pulled out. The temperature measurement was ceased at that point. During recovery, shivering was evaluated by an independent well-skilled observer (anesthesia doctor or nurse) blinded to the study. The shivering was graded using a four-point scale: 0 = no shivering; 1 = Mild fasciculations of face or neck; 2 = Visible tremor involving more than one muscle group; 3 = Gross muscular activity involving the entire body. [10]

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) Windows version 10.0. All data were expressed as mean ± SD and analyzed using paired T-test. $P < 0.05$ were considered statistically significant.

3. Results

The two groups did not differ significantly in age, weight, height, gender, duration of anaesthesia, fluids administered and ASA class (Table 1).

Changes in core temperature of the two groups are shown in Fig. 1. Before operation, the core temperature between control group and test group was not differ significantly, 37.1±0.1℃ and 37.0±0.1℃ respectively. In control group, core temperature decreased to 35.5±0.3℃ during the first 3 hours, and then stabilized at the end of anesthesia. However, the change of core temperature in test group was smaller than control group. In test group, core temperature decreased to 36.5±0.1 ℃ during the first 60 min, increased slowly after that and increased to 36.9±0.3 ℃ at the end of anesthesia.

The shivering test showed that 8 patients shivered at grade ≥ 2 in control group, while none of the patients reached grade ≥ 2 in test group. ($P < 0.01$).

Table 1. Patient characteristics of the two groups. Data are given as mean (range), mean ± SD or absolute numbers (n=15)

	control group	**test group**
Age (year)	43 (18–65)	45 (18–65)
Weight (kg)	67 ±6	65 ±10
Height (cm)	167 ±10	165±8
Gender (Female/male)	9/6	10/5
Duration of anaesthesia (min)	174 ±14	164 ±11
Fluids administered (litre)	2.1±0.4	2.0±0.3
ASA I/II	10/5	9/6

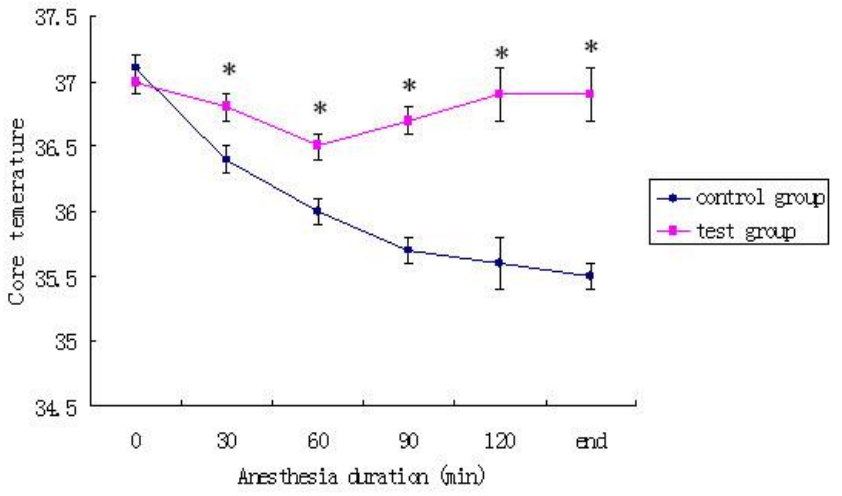

Fig. 1. changes of core temperature in control group and test group. * P<0.05 between two groups

4. Discussion

In our study, random digits table was used to randomly allocate the patients to two groups (15 patients each group), not differ significantly in age, weight, height, gender, duration of anaesthesia, fluids administered, ASA class (Table 1) and core temperature (1) before operation. It made the result reproductive and credible. Clean laminar flow operation room was used to maintain the ambient temperature and ambient relative humidity during the operation which can finely control the temperature and humidity. Core temperature was measured at the tympanic site. D Hasper et al. [11] showed that tympanic measurement had a very small bias of 0.021℃ (±0.80℃) compared with oesophageal temperature and tympanic measurement may provide an easy and non-invasive method for temperature monitoring.

The major finding of our study is that it is effective to keep patients nearly normothermic roved by it by using infusion of warm fluid during abdominal surgery. We speculate that is because maintenance of perioperative normothermia may prevent from adverse outcomes. Before, many active warming techniques for minimizing hypothermia have been described and recommended[12], such as higher room temperatures, airway heat conservation, convective warming, and more. Fluid warming is an important method of heat conservation. [13] In our study, we found that core temperature in test group decreased during the first 60 min, but it maintained over 36.5 ℃ and increased to 36.9℃ at the end of anesthesia, while core temperature in control group was decreased to 35.5 ℃ at the end of anesthesia. The differences in core temperature between two groups can be explained by the mechanisms and magnitude of intraoperative heat loss due to unwarmed intravenous fluids. [14] Infusion of 3 L of unwarmed crystalloid represents a negative thermal shift of approximately 48 kcal. Because body temperature decreases approximately 1.0℃ for every 64 kcal heat loss in excess of production, one might expect a difference in core temperature of 0.5 to 1.0 ℃ between two groups. Our study demonstrated that compared with room temperature fluids, warming intravenous fluids during operation resulted in a higher core temperature close to normothermia.

Besides, we found that infusion of warm fluid can decrease the incidence of postanaesthetic shivering. The shivering is physiological response to the hypothermia during operation, which will bring about uncomfortableness to the patients and increase oxygen consumption by roughly 40% to 120%.[15] Mild hypothermia is a core body temperature of 34 ° C to 35 ° C (93.2 ° F to 95 ° F). [16] Mild perioperative hypothermia encourages the appearance of postanaesthetic shivering, although it does not consequentially occur before postanaesthetic shivering. And the more serious the hypothermia is, the higher the probability incidence of postanaesthetic shivering will be. Furthermore, many studies have emphasized the major role of perioperative hypothermia on the onset of myocardial ischaemia, bleeding during surgical procedures, infections of the surgical wound, and more. [17] So keeping a normal core temperature is important to prevent postanaesthetic shivering. In our study, no incision rupture was observed after operation, but shivering was observed in both groups. We found that none of the patients in test group shivered at grade ≥2 while 53%(8/15) patients in control group reach grade ≥2. It demonstrated that warming intravenous fluids during operation could prevent from postanaesthetic shivering by maintaining the temperature close to normal.

The additional cost of the Hotline IV fluid warmer used to keep the infusion fluid warm at 37 ℃ was low. However, the effectiveness was obvious on preventing perioperative hypothermia. We also thought that infusion of warm fluid conjugated with other techniques for minimizing hypothermia might take the advantage of them and be more beneficial for perioperative body temperature control. The hypothesis would be studied in our future research.

In summary, it is reasonable for us to believe that infusion of warm fluid is an effective way to keep patients nearly normothermic and to prevent complications followed.

References

[1] Young VL, Watson ME. Prevention of perioperative hypothermia in plastic surgery. Aesthet Surg J. 2006;26: 551-71.
[2] Burger L, Fitzpatrick J. Prevention of inadvertent perioperative hypothermia. Br J Nurs. 2009;18:1115-9.
[3] Putzu M, Casati A. Clinical complications, monitoring and management of perioperative mild hypothermia: anesthesiological features. Acta Biomed. 2007;78:163-9.
[4] Kurz A, Sessler DI. Heat balance and distribution during the core-temperature plateau in anesthetized humans. Anesthesiology. 1995;83:491-9.
[5] Frank SM, Beattie C, Christopherson R, et al. Epidural versus general anesthesia, ambient operating room temperature, and patient age as predictors of inadvertent hypothermia. Anesthesiology. 1992;77:252-7.
[6] Eberhart LH, Döderlein F, Eisenhardt G, et al. Independent risk factors for postoperative shivering. Anesth Analg. 2005;101:1849-57.
[7] Recommended practices for the prevention of unplanned perioperative hypothermia. In: Perioperative Standards and Reeommended Praetiees. Denver, CO: AORN, Inc;2008:407-420.
[8] Gentilello LM, Cortes V, Moujaes S, et al. Continuous arteriovenous rewarming: experimental results and thermodynamic model simulation of treatment for hypothermia. J Trauma. 1990;30:1436-49.
[9] Janicki PK, Stoica C, Chapman WC, et al. Water warming garment versus forced air warming system in prevention of intraoperative hypothermia during liver transplantation: a randomized controlled trial. Anesthesiology. 2002;2:7-11.
[10] Dal D, Kose A. Efficacy of prophylactic ketamine in preventing postoperative shivering. Br J Anaesth. 2005;95:189-92.
[11] Hasper D, Nee J. Tympanic temperature during therapeutic hypothermia. Available at: www.bmj.com. Accessed June 26, 2010.
[12] Hooper VD, Chard R, Clifford T, et al. ASPAN's evidence-based clinical practice guideline for the promotion of perioperative normothermia. J Perianesth Nurs. 2009;24:271-87.
[13] Smith CE, Gerdes E, Sweda S, et al. Warming intravenous fluids reduces perioperative hypothermia in women undergoing ambulatory gynecological surgery. Anesth Analg. 1998;87:37-41.
[14] Smith CE, Desai R. Preventing hypothermia: convective and intravenous fluid warming versus convective warming alone. J Clin Anesth. 1998;10:380-5.
[15] Alfonsi P. Postanaesthetic shivering, Epidemiology, pathophysiology and approaches to prevention and management. Minerva Anestesiol. 2003;69:438-42.
[16] CYNTHIA A, PAULIKAS. Prevention of unplanned perioperative hypothermia. AORN J. 2008;88:358-64.
[17] Schmied H, Kurz A. Mild hypothermia increases blood loss and transfusion requirements during total hip arthroplasty. Lancet. 1996; 347:289-92.