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Anesth Analg 2009; 108:199-201
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 doi: 10.1213/ane.0b013e31818e6199

TECHNOLOGY, COMPUTING, AND SIMULATION

The Efficacy of a Resistive Heating Under-Patient Blanket Versus a Forced-Air Warming System: A Randomized Controlled Trial

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Abstract

BACKGROUND: We compared temperature changes in patients undergoing hip replacement during warming with a resistive heating blanket or air-forced system.

METHODS: Fifty-six patients were enrolled. Patients were randomly allocated to the "forced-air group" (forced-air system) or to the "heating-blanket group" (resistive heating under-patient blanket).

RESULTS: Baseline tympanic temperatures were $36.0 \pm 0.6^\circ\text{C}$ in the forced-air group and $36.1 \pm 0.4^\circ\text{C}$ in the heating-blanket group ($P > 0.05$). At the end of surgery tympanic temperatures were $35.3 \pm 0.5^\circ\text{C}$ in the forced-air group and $35.1 \pm 0.6^\circ\text{C}$ in the heating-pad group ($P > 0.05$).

CONCLUSIONS: We demonstrated that, using either a resistive heating-blanket or forced-air warming systems, patients ended surgery in mild hypothermia after elective total hip replacement,

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but without significant differences between these two warming devices.

► Introduction

The efficacy of surface warming devices depends on heat transfer per unit area.¹ Even inefficient warmers may perform adequately when enough surface is available for warming.¹ Forced-air warming systems have a low heat transfer per unit area, but the usual availability of sufficient skin area makes forced-air devices the routine method of warming surgical patients.^{2,3} There are, nonetheless, some surgical procedures during which forced-air warming may be inadequate.¹

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A resistive carbon-fiber warming system has recently been developed (DM-WARM 12). It is applied over the operating table and transfers heat to the available posterior skin surface.

The aim of this prospective, randomized, controlled study was to compare temperature changes in patients undergoing major orthopedic surgery and spinal anesthesia during patient warming with a resistive carbon-fiber heating blanket or forced-air system.

► METHODS

After approval from our local ethics committee and written informed consent, we enrolled 56 patients undergoing elective total hip replacement. Inclusion criteria were age between 18 and 80 yr, ASA physical status I-III and duration of anesthesia longer than 1 h. Exclusion criteria were neurological deficits, history of head injury, thyroid disease, disturbance of autonomic function, severe cardiovascular and respiratory disease, preoperative core temperature $\geq 37.5^{\circ}\text{C}$, evidence of current infection, the use of steroids and vasoactive drugs or contraindications to regional anesthesia.

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The operating room had controlled laminar air flow with the room temperature set at 21°C and relative humidity of 40%.

Before anesthesia, temperature was measured in each patient with a tympanic temperature probe (Mon-a-therm®, Covidien). In addition, every 15 min an infrared tympanic thermometer (First Temp Genius®, Sherwood Medical, UK) was used to measure temperature in the opposite ear in both groups. The readout of the temperature monitor was in 0.1°C increments.

Each patient's basal temperature (T_0) was measured with these 2 methods before anesthesia and every 15 min during the surgery for at least 120 min.

A 7 mL/kg IV crystalloid solution was administered over a 15-min period before anesthesia. Each patient received a continuous lumbar plexus block for postoperative analgesia and a spinal block with 15 mg of levobupivacaine 0.75%.

After anesthesia, patients were randomly allocated, via sealed envelope assignment, to 1 of 2 groups.

Randomization was based on a computer-generated list.

All patients in the forced-air system group (group FAS) were warmed by a FAS (WARM TOUCH®, Covidien) and the cover was applied to each patient's chest, abdomen, and both arms (27% of body surface). The warming unit was set on high (43°C). All patients in the heating-blanket group (group HB) received a resistive carbon-fiber heating blanket (DM-Warm 12®, Diemme International s.r.l., Italy). The blanket was placed on the operating table in direct contact with each patient's back, one arm and one leg (31.5% of body surface). The warming system was set on high (40.7°C). No preoperative warming was allowed and both devices were turned on after spinal block was performed. All IV fluids were warmed to 37°C with an infusion warmer (WARMFLO®, Covidien). A $5 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$ infusion of lactate Ringer's solution was given IV throughout surgery, while 3 mL of the same solution was administered for every 1 mL of blood loss. Demographic and anthropometric characteristics, pre- and postoperative hemoglobin and hematocrit, duration of surgery, infused crystalloids, ephedrine use, intra- and postoperative blood losses were registered. To detect a clinically relevant difference equal to 0.3°C in final tympanic core temperatures, we prospectively calculated that 28 patients were required in each group assuming a standard deviation (SD) of 0.4°C⁴ ($\alpha = 0.05$; $\beta = 0.2$). The distribution of data was evaluated using the Kolmogorov-Smirnov test. Comparisons between groups were performed using unpaired *t*-test for parametric variables. Nonparametric variables were analyzed with Mann-Whitney *U*-test. Categorical data were described using number (percentage) and comparisons between groups were made using the contingency table analysis and the Fisher's exact test. Continuous variables are presented as mean $\pm$ sd for normally distributed data, or median (range) for not normally distributed data. Changes in core temperature from control over time, in each group, were compared using repeated measures analysis of variance. The Bland Altman test was used to investigate correlation between tympanic probe measures and infrared tympanic temperatures.

A *P* value ≤ 0.05 was statistically significant. All analysis were performed using SPSS 13.0 (Chicago, 2004).

► RESULTS

All patients were treated per protocol. There was no evidence of thermal burns on any of the patients.

The demographic and anthropometric characteristics, preoperative and postoperative hemoglobin and hematocrit values, intraoperative and postoperative blood loss, ephedrine use, infused crystalloids, and hemodynamic variables were comparable between groups ([Table 1](#)).

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View this table: **Table 1.** Characteristics and Anesthetic/Surgical Details of Patients
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Duration of surgery was 90 ± 24 min in the group FAS and 88 ± 31 min in group HB ($P = 0.33$). Tympanic temperatures measured with aural probe and infrared thermometer are shown in [Figures 1 and 2](#). Baseline tympanic core temperatures measured with the aural probe (T_0) were $36.0 \pm 0.6^\circ\text{C}$ for patients in group FAS and $36.1 \pm 0.4^\circ\text{C}$ for those in group HB. The infrared tympanic temperature at T_0 was $36.3 \pm 0.7^\circ\text{C}$ in group FAS and $36.6 \pm 0.5^\circ\text{C}$ in group HB. At the completion of surgery, tympanic probe temperatures (T_{end}) were $35.3 \pm 0.5^\circ\text{C}$ in group FAS and $35.1 \pm 0.6^\circ\text{C}$ in group HB. The infrared tympanic temperature at T_{end} was $35.5 \pm 0.7^\circ\text{C}$ in group FAS and $35.3 \pm 0.7^\circ\text{C}$ in group HB ([Table 2](#)).

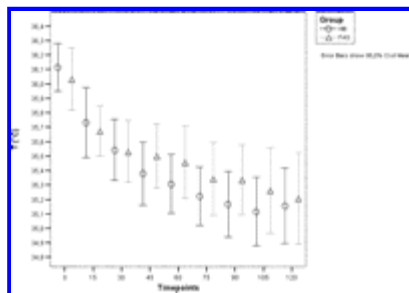


Figure 1. Tympanic temperatures (Mon-a-therm, Covidien) in patients warmed with resistive heating blanket (group HB) or forced-air system (group FAS) during total hip replacement. Values are means with confidence intervals 95%.

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View this table: **Table 2.** Temperatures in Patients Warmed with Resistive Heating Blanket (Group HB) or Forced-Air System (Group FAS) at the End of Surgery (total hip replacement). All Measurements are Reported: Infrared Tympanic Temperatures (First Temp Genius, Sherwood Medical, UK), Tympanic Temperatures Measured with Tympanic Probe (Mon-a-therm, Covidien) in Both Groups
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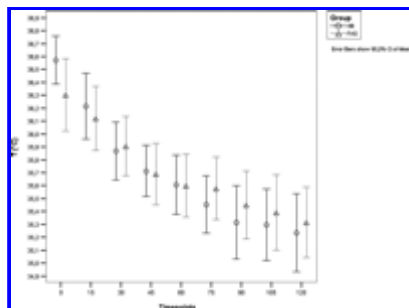


Figure 2. Infrared tympanic temperatures (First Temp Genius, Sherwood Medical, UK) in patients warmed with resistive heating blanket (group HB) or forced-air system (group FAS) during total hip replacement. Values are means with confidence intervals 95%.

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There was no statistical difference between groups either at baseline (T_0) or at the last mean measure T_{end} . We found a correlation between infrared tympanic temperatures and tympanic probe temperatures.

► DISCUSSION

This prospective, randomized trial demonstrated that, during spinal anesthesia and lumbar plexus block for total hip replacement, a resistive carbon-fiber heating blanket results in body temperature changes that are similar to those achieved with a forced-air warming system. Both groups ended surgery with mild hypothermia as a consequence of core-to-periphery redistribution of body heat, in the absence of prewarming.^{5–7} We, therefore, demonstrated that, using either a resistive heating blanket or forced-air warming systems, patients ended surgery in mild hypothermia after elective total hip replacement, but without significant differences between these two warming devices.

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Accepted for publication August 8, 2008.

Supported by the University of Parma, viale Gramsci 14, 43100 Parma PR, Italy.

► REFERENCES

1. Wadhwa A, Komatsu R, Orhan-Sungur M, Barnes P, In J, Sessler DI, Lenhardt R. New circulating-water devices warm more quickly than forced-air in volunteers. *Anesth Analg* 2007;105:1681–7
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2. Berti M, Fanelli G, Casati A, Aldegheri G, Lugani D, Torri G. Hypothermia: prevention and therapy. *Anaesthesia* 1998;53:46–7
[\[Medline\]](#)
3. Casati A, Baroncini S, Pattono R, Fanelli G, Bonarelli S, Musto P, Berti M, Torri G. Effects of sympathetic blockade on the efficiency of forced air warming during combined spinal/epidural anesthesia for total hip arthroplasty. *J Clin Anesth* 1999;11:360–3
[\[Medline\]](#)
4. Negishi C, Hasegawa K, Mukai S, Nakagawa F, Ozaki M, Sessler DI. Resistive-heating and forced-air warming are comparably effective. *Anesth Analg* 2003;96:1683–7
[\[Abstract/Free Full Text\]](#)
5. Matsukawa T, Sessler DI, Christensen R, Ozaki M, Schroeder M. Heat flow and distribution during epidural anaesthesia. *Anesthesiology* 1995;83:961–7
[\[ISI\]](#)[\[Medline\]](#)
6. Just B, Trevien V, Delva E, Lienhart A. Prevention of intraoperative hypothermia by preoperative skin-surface warming. *Anesthesiology* 1993;79:214–18
[\[ISI\]](#)[\[Medline\]](#)
7. Glosten B, Hynson J, Sessler DI, McGuire J. Preanesthetic skin-surface warming reduced redistribution hypothermia caused by epidural block. *Anesth Analg* 1993;77:488–93
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