CLINICAL EVALUATION OF THE OESOPHAGEAL HEAT EXCHANGER IN THE PREVENTION OF PERIOPERATIVE HYPOTHERMIA

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SUMMARY
We have studied the efficiency of an oesophageal warming device in the prevention of perioperative hypothermia in 22 patients undergoing total hip replacement. Aural canal and skin temperatures (15 sites) were measured before induction of anaesthesia, at the end of surgery and 1 h after recovery and mean body heat was calculated to quantify heat distribution. Core temperature decreased significantly in both groups at the end of surgery, by a mean of 1.8°C in the control group and 1.3°C in the oesophageal heat exchanger (treated) group (P = 0.09). In contrast, mean skin temperature at the end of surgery increased by a median value of 0.26°C in the treated group and decreased by 1.02°C in the control group (P = 0.03). Both groups of patients lost body heat to the same extent (P = 0.34). Thus the oesophageal heat exchanger was ineffective in preventing perioperative hypothermia in a group of patients undergoing total hip replacement.

KEY WORDS

Heat loss can occur during anaesthesia and surgery, and the resultant hypothermia might lead to increased morbidity and mortality, especially in the high risk population, such as the elderly with poor cardiovascular reserves [1]. The oesophagus is a convenient site for core (central) warming in anaesthetized patients, being easily accessible and situated in close proximity to the major blood vessels, thus acting as a good conduit for heat transfer. An oesophageal thermal device has been designed and shown to be effective in delivering heat and in the prevention of perioperative hypothermia [2]. We have examined the efficacy of the oesophageal warming device in the prevention of perioperative hypothermia in patients undergoing total hip replacement in a cool operating environment, by measuring core (tympanic) and skin temperatures at 15 sites.

METHODS AND RESULTS
After obtaining Ethics Committee approval and informed consent, we studied 22 patients (ASA I and II), apyrexial and with no underlying oesophageal disease, undergoing elective unilateral total hip replacement. They were randomly allocated to two groups: a control group (n = 11) (median age 73 yr (range 34-83 yr); weight 64 kg (range 48-90 kg)), with no active warming technique in the intra-operative period and a treated group (n = 11) (median age 71 yr (range 52-82 yr); weight 66 kg (range 46-90 kg)) using the oesophageal heat exchanger system.

The oesophageal thermal tube (Granulab, Pencco Medicals Ltd, London) was tested before each study for water leaks, obstruction in the connections and any evidence of damage. After induction of anaesthesia and tracheal intubation, a well lubricated oesophageal thermal tube was inserted and placed in the oesophagus. The oesophageal heat exchanger was connected to a MicroTemp water heating pump (SeaBrook Medical Inc.), set at 50 litre hr⁻¹, to give a temperature of 40°C (range 38-41°C) in the oesophageal tube. The heating was commenced before surgical incision and was maintained until the end of surgery, when the oesophageal warming device was removed. The median duration of surgery was 103 min.

The patients were premedicated with i.m. papa-veretum 10-15 mg 1 h before surgery. All patients received general anaesthesia comprising thio-pentone, pancuronium, nitrous oxide in oxygen and enflurane (inspired concentration 1-1.3%). Hartmann's solution was infused i.v. at room temperature and blood, if required, was transfused after being warmed to 37.0°C.

Tympanic temperature was recorded with the MON-A-THERM (Mallinckrodt) temperature probes, calibrated in the temperature range of 25-40°C and accurate to 0.1°C. Skin temperatures were measured at 15 points, using the Infra-red Radiation Thermometer (Minolta Cyclops 33), obviating the need for placing temperature probes on the skin [3].

Temperature readings were taken before induction.
OESOPHAGEAL HEAT EXCHANGER FOR PERIOPERATIVE HYPOTHERMIA

Table 1. Median (range) core and skin temperatures and total body heat (TBH) changes, P values and 95% confidence limits for differences between control and treated group (95% CL). BI = Before induction; ES = end of surgery; R = 1 h in recovery.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Treated</th>
<th>P</th>
<th>95% CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core temp. (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES-BI</td>
<td>-1.80 (-3.40, -0.30)</td>
<td>-1.30 (-2.20, -0.40)</td>
<td>0.09</td>
<td>(-1.00, 0.10)</td>
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<tr>
<td>R-ES</td>
<td>1.05 (-0.20, 1.70)</td>
<td>0.50 (-0.50, 1.40)</td>
<td>0.13</td>
<td>(-0.10, 1.10)</td>
</tr>
<tr>
<td>Mean skin temp. (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES-BI</td>
<td>-1.02 (-2.13, 1.18)</td>
<td>0.26 (-3.38, 2.16)</td>
<td>0.03</td>
<td>(-2.03, -0.17)</td>
</tr>
<tr>
<td>R-ES</td>
<td>1.41 (-0.51, 3.08)</td>
<td>0.06 (-2.34, 1.22)</td>
<td>0.004</td>
<td>(0.23, 2.17)</td>
</tr>
<tr>
<td>TBH (kJ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES-BI</td>
<td>-318 (-675, -114)</td>
<td>-219 (-613, 25)</td>
<td>0.34</td>
<td>(-247, 89)</td>
</tr>
<tr>
<td>R-ES</td>
<td>185 (70, 489)</td>
<td>69 (-95, 352)</td>
<td>0.02</td>
<td>(40, 297)</td>
</tr>
</tbody>
</table>

COMMENT

We have found that the oesophageal heat exchanger was ineffective in preventing the decrease in core temperature and body heat content during hip surgery. However, measurement of surface skin temperatures at 15 sites in the treated group showed an increase in mean skin temperature at the end of surgery.

In spite of its bulk, the oesophageal warming device was easy to insert and there was no trauma to oesophageal tissue. The exact location in the oesophagus could be checked and, because of its design, rapid warming of the surrounding structures could be achieved. Nevertheless, core temperature decreased by more than 1 °C in the treated group. One possible explanation for this change may be the fact that the lower one-third of the oesophagus is less perfused than the surrounding structures. In addition, the pressure exerted by the rubber sheath on the oesophageal wall might affect heat transfer. Thus, although the device is in close proximity to large vessels, it may not be the most efficient site for transferring heat to the rest of the body. Another reason for the observed decrease in core temperature could be the low operating theatre temperature (19–20 °C in this study), leading to considerable heat loss from the periphery in the form of cutaneous heat flux. The distribution and transfer of body heat through the skin in relation to the environmental temperature plays a considerable part in temperature homeostasis.

The decrease in core temperature observed in the oesophageal heat exchanger group at the end of surgery was associated with increased mean skin temperatures, which would suggest a response to core warming and a consequent redistribution of body heat to the periphery. A similar response to core warming has been reported previously, in a similar population undergoing hip arthroplasty in a cool environment [6]. However, those patients were warmed actively by means of a heated humidifier, set at 40.0 °C, in the breathing system. Their mean skin temperature increased significantly, by 0.7 °C, while the decrease in core temperature was very small (0.3 °C). These findings would, therefore, indicate the importance of efficient and adequate core warming to attenuate radiation heat loss; this was not achieved efficiently in our study using the oesophageal heat exchanger.

ACKNOWLEDGEMENT

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REFERENCES

3. Ramachandra V, Allan LG, Carli F. The Cyclops 33 radiation

