and its position in the distal esophagus was adjusted by maximal heart tones via the esophageal stethososcope.[17]

Skin-temperature gradients were used to evaluate thermoregulatory vasoconstriction of the arm. The gradient was calculated by subtracting fingertip skin temperature from midforearm skin temperature. To measure skin surface temperature gradients, disposable, self-sticking SMS-0462 (Seebook) skin-surface thermocouples were attached to each patient's nondependent arm, which was positioned at the level of the right atrium. The forearm thermocouple was placed on the radial side of the arm midway between the wrist and elbow; the fingertip probe was positioned on the tip of the index finger opposite the nail bed. The monitored arm was kept well away from the circulating water blanket and had no intravenous catheter or blood pressure cuff in place. All thermocouple sites were fully exposed to room air.

As in previous studies, a forearm minus fingertip skin-temperature gradient exceeding 4 °C was considered definitive vasoconstriction.[6] The thermoregulatory threshold for vasoconstriction was defined as the esophageal core temperature at which definitive vasoconstriction was first observed. Skin-surface and esophageal temperatures, blood pressure, and heart rate were recorded every 5 min from induction until closure of the surgical incision. All continuous variables were analyzed using unpaired Student's *t*-test. Data are expressed as the mean SD. Values of $p < 0.05$ were considered statistically significant.

RESULTS

We collected complete data on 14 patients in this study. Nine patients were anesthetized without a warming protocol (control group). The other 5 patients were anesthetized with active warming as described above (warming group). Demographic data and operative data for the 2 groups are presented in Table 1. There were no significant differences between the 2 groups.

The 9 patients in the control group became hypothermic and showed thermoregulatory vasoconstriction at a mean esophageal temperature of 35.2 ± 0.7 °C. Thereafter the patients' temperature remained in a static hypothermic state (Fig. 1). In contrast, the 5 patients in the warming group remained nearly normothermic with a mean lowest esophageal temperature of 36.3 ± 0.4 °C (Fig. 2) ($p < 0.01$). Skin-surface temperature gradients were < 2 °C in all 5 actively warmed patients (Fig. 3) and were > 4 °C in all 9 hypothermic

Table 1. Demographic cHaracteristics

	Warming ($n = 5$)	Non-warming ($n = 9$)
Gender (male/female)	2/3	3/6
Age (years)	36 ± 11	34 ± 10
Height (cm)	159 ± 9	160 ± 7
Weight (kg)	58 ± 7	51 ± 10
Operative time (min)	386 ± 66	380 ± 65
OR temperature (°C)	21.8 ± 1.0	22.0 ± 1.1
Body temperature (°C) (pre-op)	36.2 ± 0.4	36.3 ± 0.4
Dose of fentanyl (mg)	126 ± 24	118 ± 22

Data are expressed as the mean ± SD.
There were no statistically significant differences between the 2 groups.

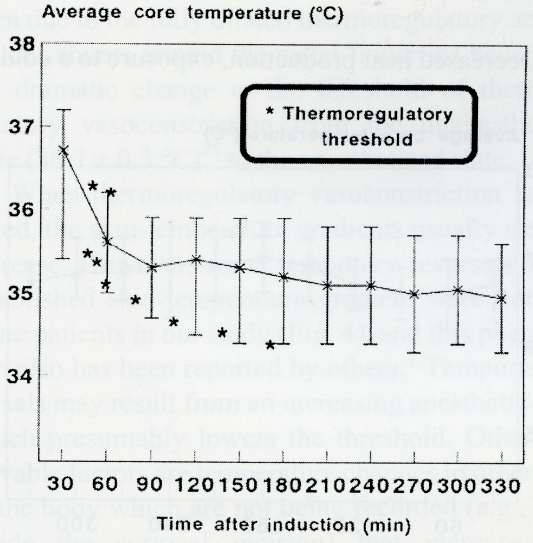

Fig. 1. Average core temperatures in 9 non-warmed patients who became hypothermic during prolonged free flap surgery. The time and the core temperature at which thermoregulatory vasoconstriction with a statistical difference between the given temperature and the baseline ($p < 0.05$) were observed are marked by an asterisk (*). The thermoregulatory thresholds were between 34.4 and 36.3 °C (35.2 ± 0.7 °C). Values are expressed as mean ± SD.