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EFFICACY OF BAIR HUGGER FORCED-AIR WARMING WITH A REUSABLE BLANKET DURING KIDNEY TRANSPLANTATION

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ABSTRACT

Background and objective : Forced-air warming by Bair Hugger proved the most efficient technique for minimizing core hypothermia . This study tested the efficacy of a reusable blanket attached to Bair Hugger for maintaining normothermia during kidney transplantation . Patients and methods : 30 kidney recipients were randomly assigned to receive no warming device (control group; n=15) or had active warming by Bair Hugger with a reusable blanket (B-H group; n=15) . Patients were anaesthetized by combined epidural and general anaesthesia . Crystalloid infusion was given at room temperature and ambient temperature was maintained at 22-24°C . Results : Basal esophageal temperature was below normal values (35.7°C) and decreased approximately by 0.2 and

0.1°C in B-H and control group respectively in the first 15 min after induction of anaesthesia. Subsequently, temperature was maintained in B-H group but continued to decrease significantly in control group. The maximum decrease of temperature in control group was detected during cold ischemia (from $34.6 \pm 0.4^{\circ}\text{C}$ to $34.0 \pm 0.5^{\circ}\text{C}$). At end of surgery , core temperature in B-H group was $35.9 \pm 0.9^{\circ}\text{C}$ compared to $34.2 \pm 0.5^{\circ}\text{C}$ in control group . All patients recovered immediately after surgery without abnormal events. Conclusion: Forced – air warming using Bair Hugger with a reusable blanket can maintain core temperature in kidney recipients without complications

INTRODUCTION

Intra-operative hypothermia usually accompanies anaesthesia and sur-

gery. It is most likely in long complicated operations, elderly patients or patients having pre-existing illness. End-stage renal failure patients subjected to kidney transplantation are more liable to hypothermia due to little body fat, low ambient temperature in the theatre in addition to cold ischemia during vascular anastomosis.

Intra-operative warming of the patients minimize the documented complications of hypothermia (1-4). Many warming devices and techniques have been used to warm the patients intra-operatively. Forced - air warming proved the most efficient one in minimizing core hypothermia (5-7). The main limitation of Bair Hugger forced - air warming is the high cost of disposable blankets. In replace, we used a reusable blanket made of 2 layers of surgical draping, the space between them is connected to the heater - blower unit .

This study was designed to test the efficacy of Bair Hugger warming device with its reusable cover to maintain intra-operative normothermia during kidney transplantation .

PATIENTS AND METHODS

Following approval of our institu-

tional ethical board, we studied 30 adult end-stage renal failure patients undergoing allograft renal transplantation in Urology and Nephrology Centre, Mansoura University. Non had fever, autonomic disorders, Raynaud's syndrome and all were above 18 years old .

Patients were premedicated by midazolam 7.5 mg orally 2 hours before induction of anaesthesia. Epidural anaesthesia was performed using a mixture of robivacaine 0.75 % (8 ml) and 2 mg morphine injected at L2-3 interspaces with a spinal needle 22G. Internal Jugular vein cannulation was secured under local lidocaine anaesthesia. General anaesthesia was induced with Fentanyl $1 \mu\text{g kg}^{-1}$, midazolam 0.05 mg kg^{-1} and thiopentone sodium ($4-5 \text{ mg kg}^{-1}$). Vecuronium 0.1 mg kg^{-1} was used to facilitate tracheal intubation and maintain muscle relaxation during surgery. Anaesthesia was subsequently maintained with $\text{N}_2\text{O}:\text{O}_2$ ($\text{FiO}_2 : 0.35$) - Isoflurane - Vecuronium. The inspired gases were not actively warmed or humidified. Crystalloid I.V. infusion was administered at room temperature at a rate of 60 ml kg^{-1} till the time of vascular declamping then it was

adjusted according to central venous pressure.

Patients were randomly allocated according to computer generated randomization into two temperature management groups : control group (n=15) received no intra-operative warming device and B-H group (n=15) had active skin surface warming. Bair Hugger- model 505 forced air warmer with its reusable fabric blanket was used. The blanket is made of 2 layers of surgical draping connected together peripherally except a small part connected to the tube of heat blower so that the space between 2 layers is blown by warm air. The blanket was applied to the skin surface of chest, neck and proximal part of both upper arms . The temperature of forced- air warmer was set on medium (38°C) and was decreased to low (32°C) in patients in whom core temperature exceeded 36.5°C. Active warming was started immediately after induction of anaesthesia. In all cases, operating room temperature was controlled near 22-24°C. If the temperature in the control group decreased less than 34°C, Bair hugger was applied till the end of surgery. Core temperature was measured with an esophageal thermistor

probe inserted through the nose to reach the distal third of the esophagus and connected to Hb monitor.

The patients were monitored by 5-leads ECG, Non- invasive blood pressure, pulse oximetry, capnography and CVP. In addition to core temperature, we recorded heart rate, mean blood pressure , ETpCO₂ and CVP changes. These data were recorded just after induction (basal) , 15 min and 1 hr after induction , before clamping of renal vessels, after vascular declamping and at end of surgery. Total amounts of crystalloids infused, duration of vascular cold ischemia, duration of surgery and state of recovery were also recorded.

The data was analyzed statistically using SPSS program version 10.0. Parametric data was analyzed by student t- test. To detect change over time in core temperature of each group, we used repeated measure ANOVA test. P value < 0.05 was considered as a level of significance.

RESULTS

Both studied groups were comparable as regard demographic characters, infused volumes, renal ischemia time, ambient temperature and dura-

tion of surgery (table 1). Males were more frequently presented than females in both treatment groups. The duration of dialysis ranged from 1 month up to 9 years and 3 patients in each group had no dialysis before. Diuresis occurred immediately in patients of both groups except 2 patients in each group in whom the diuresis delayed up to 10 - 30 min. Comparable ETpCO₂ readings (30 - 32 mmHg) were maintained all over the study period in both groups indicating adequate ventilation.

Basal core body temperature of both groups were below normal values (35.7°C) and decreased approximately by 0.2 and 0.1°C in B-H and control group respectively in the first 15 minutes after induction of anaesthesia (table 2). Subsequently, core temperature was maintained in patients given forced - air warming but continued to decrease significantly in control group as compared to either basal reading or the same reading in B-H group (table 2) . The maximum decrease of core temperature in con-

rol group was detected during cold ischemia (from 34.6 ± 0.1 °C to 34.0 ± 0.5 °C). At the end of surgery, core temperature in B-H group was 35.9 ± 0.9 °C compared to 34.2 ± 0.5 °C in control group . Forced - air warming was applied to 3 patients in control group after vascular declamping till recovery as temperature dropped to less than 34.0°C.

The haemodynamic parameters (HR and MBP) were maintained within normal range throughout study period in spite of significant decrease in heart rate as compared to basal reading in both groups (table 3). Central venous pressure did not elicit a noticeable difference between the two groups during the studied period. This variable increased gradually till the end of vascular anastomosis where it declined in both groups due to occurrence of brisk diuresis (figure).

All patients recovered immediately after surgery without any abnormal events or complications.

Table 1 : Demographic , Infused volumes and Surgical data of forced-air warming (B-H) and control groups . Data are mean \pm SD (range) or number .

	B-H group	Control group
Age (Y)	36.0 \pm 12 (20 -53)	30.9 \pm 9 (19 -52)
Sex (M/F)	12/3	9/6
Body weight (kg)	68.9 \pm 17 (37 - 97)	60.9 \pm 9 (46 -77)
Infused volumes (L)	3.03 \pm 0.5 (2 - 4.5)	2.9 \pm 0.3 (2.5 - 3.5)
Renal Ischemia time (min)	51.9 \pm 13 (34 - 82)	52.4 \pm 14 (32 -75)
Ambient temperature ($^{\circ}$ C)	23.1 \pm 0.7 (22 - 24)	23.2 \pm 0.6 (22 -24)
Duration of surgery (min)	297.3 \pm 26 (250 - 340)	316.0 \pm 26 (260 - 395)

Table 2 : Core temperature ($^{\circ}$ C) of forced - air warming (B-H) group and control group . Values are mean \pm SD .

	B-H group	Control group
Basal	35.7 \pm 0.5	35.7 \pm 0.4
After induction :		
15 min	35.5* \pm 0.5	35.6* \pm 0.4
1 hr	35.6 \pm 0.5	34.9** \pm 0.6
Before clamping	35.7 \pm 0.7	34.6** \pm 0.4
After declamping	35.5 \pm 0.8	34.0** \pm 0.5
End of surgery	35.9 \pm 0.9	34.2 ** \pm 0.5

* Significant difference between the 2 groups (P < 0.05) .

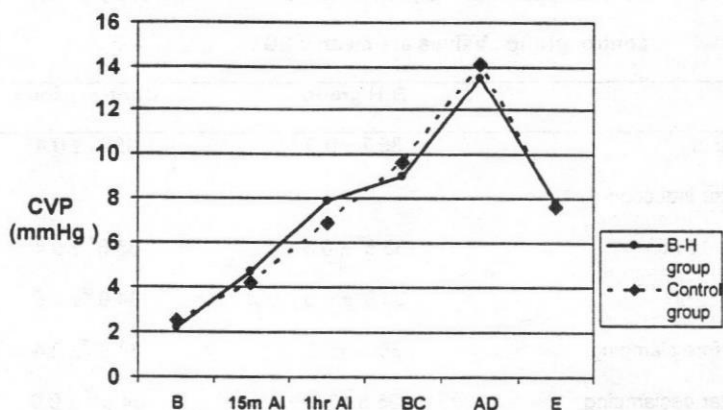
** Significant decrease than basal value in the same group (P < 0.05) .

EFFICACY OF BAIR HUGGER FORCED-AIR WARMING *etc.***Table 3 :** Haemodynamic changes of forced - air warming (B - H) groupand control group. Values are mean \pm SD .

	Heart rate (bpm)		Mean blood pressure (mmHg)	
	B-H	Control	B-H	control
Basal	91 \pm 18	88 \pm 13	85 \pm 12	87 \pm 15
After induction :				
15 min	83 [#] \pm 16	82 [#] \pm 15	82 \pm 15	83 \pm 12
1 hr	83 [#] \pm 16	77 [#] \pm 13	88 \pm 14	92 \pm 14
Before clamping	84 [#] \pm 15	71 [#] \pm 10	84 \pm 12	87 \pm 10
After declamping	90 \pm 12	79 [#] \pm 11	82 \pm 11	84 \pm 10
End of surgery	90 \pm 16	79 [#] \pm 15	93 \pm 13	92 \pm 10

* Significant difference between the 2 groups (P < 0.05) .

* Significant decrease than basal value in the same group (P < 0.05) .

**Figure :** Central venous pressure of forced-air warming (B-H) group and control group. Values are means.B= Basal 15m AI = 15 min after induction 1hr AI = 1hr after induction
BC = Before clamping AD = After declamping E = end of surgery .

DISCUSSION

Roughly 90% of metabolic heat is lost through the skin surface therefore, any effective warming system must control cutaneous heat loss. This can be achieved by either passive insulation or active cutaneous heating. Passive insulation rarely reduce heat loss even by 30 – 50 %⁽⁸⁾. Forced – air warming was proved as more effective than passive insulation^(5,9), circulating – water mattresses⁽¹⁰⁾, Radiant heat device⁽¹¹⁾ and as effective as electric blanket ⁽¹²⁾ . However, one of the drawbacks with forced – air systems is the expense of the single use blanket. So, in this study we used a simple reusable fabric cover made of 2 layers of surgical draping and applied to the anterior skin surface of chest , neck and proximal parts of upper limbs. However in a similar study⁽¹⁰⁾, the blanket was covering legs and warming was as effective as our technique.

Our results indicated that forced – air warming using Bair Hugger with this reusable blanket was effective in maintaining core temperature during kidney transplantation. Although it was significantly higher than in control group , unfortunately, core temperature never reach 36° C which is con-

sidered the lower limit for normal temperature in surgical patients. Three contributing factors might be involved. Firstly, fluids were infused at room temperature. It was evident that 1 liter of crystalloid solution administered at room temperature decrease mean body temperature approximately 0.25°C in adults ⁽¹³⁾. This indicate that in our patients, the fluid volume given (≈ 3 L) might decrease core temperature by 0.75°C. The second factor was direct application of ice bags on major vessels during renal vascular anastomosis (about 30 – 80 minutes) which add more hypothermia during this period. The third most important factor is that active warming was started after induction of general anaesthesia allowing redistribution hypothermia to occur and this was the cause of decrease in core temperature in the first hour after induction. It was reported that operative warming 1 hr before induction of anaesthesia avoided redistribution hypothermia caused by general anaesthesia ⁽¹⁴⁾ or following epidural anaesthesia ⁽¹⁵⁾. Our patients were relatively cool at start of anaesthesia (mean core temperature 35.7°C) like most of hospitalized patients due to low ambient temperature, skimpy clothing, infirmity or underlying illness. Thus, we recom-

mend active cutaneous pre-warming to start as soon as patients are admitted to pre-surgical holding area.

However, this mild hypothermia seems beneficial in kidney recipients to meet the reduction of O₂ delivery to the tissues due to decreasing O₂ carrying capacity. This is achieved through parallel reduction of oxygen consumption by the tissues due to mild hypothermia.

It was reported that hypothermia might prolong recovery from general anaesthesia (4) due to increased solubility of volatile anaesthetics and reduced metabolism of I.V. drugs. However, in this study no cases of delayed recovery was reported and, surprisingly, all patients in control group (mean temperature at end of surgery = 34.2°C) recovered immediately after surgery. Perhaps, epidural analgesia – reducing greatly the dose of muscle relaxants and volatile anaesthetic concentration – explain the rapid recovery from anaesthesia.

In conclusion, forced – air warming using Bair Hugger with a reusable blanket can maintain core temperature in kidney recipients without com-

plications . It may be more efficient if pre-warming started before induction of anaesthesia.

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