Original Research Article

Indian Journal of Anesthesia and Analgesia
2018; 5(8): 1308-1313
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.5818.9

Comparative Study of Prevention of Hypothermia Using Preoperative as well as Intraoperative Forced Air Warming with Only Intraoperative Warming in Patients of Surgeries Under General Anaesthesia

Tanna Dhara B.[1], Kharod Utpala N.[2]

[1]Assistant Professor, Department of Anaesthesia, GMERS Medical College, Gotri, Vadodara, Gujarat 390021, India. [2]Dean and Professor, Pramukhswami Medical College, Karamsad, Anand, Gujarat 388325, India.

Abstract

Background: Peri-operative hypothermia is very common and associated with many complications. Hypotheremia is most evident in first two hours due to redistribution of heat after induction of general anaesthesia. The study was conducted to compare the effect of pre-warming and intraoperative warming with only intraoperative warming in patients undergoing long duration surgeries under general anaesthesia where following parameters were studied: Core body temperature as a primary outcome and hemodynamic parameters, extubation time, post anaesthesia recovery and postoperative shivering as secondary outcomes. *Methods:* In this prospective interventional study, 40 patients between 18-70 years of age were divided into two groups. Group A received preoperative as well as intraoperative forced air warming. Group B received only intraoperative forced air warming with Bair Hugger. Intra-operatively, core body temperature and hemodynamics were monitored. Extubation time and post operative recovery score were recorded after surgery. *Results:* It was observed that after induction of general anaesthesia core temperature started decreasing in both the groups but the fall was more in group B, which was statistically significant till 150 minutes. After that period the difference was insignificant till the end of the surgery. No significant difference in any other parameter studied was observed in both the groups. *Conclusion:* Preoperative warming with forced air warmer is definitely effective in preventing redistribution hypothermia for initial two hours of surgery. However, the overall immediate outcome is not affected as per observations made in our study.

Keywords: Forced Air Warming; Hypothermia; Pre-Warming; Redistribution Hypothermia.

How to cite this article:

Tanna Dhara B. & Kharod Utpala N. Comparative Study of Prevention of Hypothermia Using Preoperative as well as Intraoperative Forced Air Warming with Only Intraoperative Warming in Patients of Surgeries Under General Anaesthesia. Indian J Anesth Analg. 2018;5(8):1308-13.

Introduction

Hypothermia is defined as a core body temperature of less than 36 degree Celsius (^{0}C) (96.8° F). Surgical patients can develop hypothermia as a result of factors in the peri-operative environment or the thermoregulatory response of the body to anesthetic agents. Core body temperature decreases during and after induction of general anaesthesia as a result of redistribution of heat from central to peripheral compartment & reduced metabolic heat production [1,2]. Hypothermia is associated with complications like: delayed recovery from anaesthesia [3], shivering [3], coagulopathy [4], increased blood loss [4,5], cardiac ischemic changes, surgical wound infections [4], negative postoperative nitrogen balance, etc. Peri-operative hypothermia is associated with prolonged stay in Post Anaesthesia Care Unit (PACU), increased chances of postoperative mechanical ventilation,

Corresponding Author: Tanna Dhara B., Assistant Professor, Department of Anaesthesiology, GMERS Medical College, Gotri, Vadodara, Gujarat 390021, India.
E mail: dr.dharatushar@gmail.com

Received on 22.04.2018, **Accepted on** 14.05.2018

prolonged hospital stay and so increased cost [2]. Forced air warming is widely used and usually maintains normothermia even during prolonged surgeries. Forced air warming uses convection heating to warm the patient. As the availability of literature of studies done in India on prevention of hypothermia is limited, the study to compare the effect of pre-warming and intraoperative forced air warming with only intraoperative forced air warming on peri-operative hypothermia, especially redistribution hypothermia was undertaken in patients undergoing long duration surgery under general anaesthesia with the aim of comparing core body temperature as a primary outcome and hemodynamics, extubation time, postoperative shivering and recovery after anaesthesia, as secondary outcomes.

Methods

A prospective interventional study was conducted at a rural based tertiary care hospital in Gujarat after approval from institutional ethics committee and after obtaining written and informed consent from all the participants. Their data was kept confidential.

Total 40 patients undergoing ENT surgeries and neurosurgeries under general anaesthesia were recruited for the study. Inclusion and exclusion criteria were as follows:

Inclusion Criteria

1. Patients of 18 to 70 years of age.
2. Duration of surgery three to six hours.
3. Patients posted for ENT surgeries and neurosurgeries.
4. Patients with American society of anaesthesiologists (ASA) Class I, II and III.

Exclusion Criteria

1. History of preoperative fever and/or on antipyretic drugs
2. Thyroid disease
3. Cushing's syndrome
4. Autonomic dysfunction
5. Core temperature >37.5^{0}C
6. Platelet dysfunction
7. Coagulopathy

On the day of surgery patients were explained about the study protocols and pre-warming & intraoperative warming in the preoperative room. Written and informed consent was taken. Baseline vital parameters including axillary skin temperature were noted before shifting the patients to operative room. Patients were allocated into two groups with 20 patients in each group randomly using a computer generated sequence by Clinical Research department. In Group A, patients received Pre-warming and intraoperative warming, while in Group B patients received only intraoperative warming. In Patients of group A, forced air blanket (Bair Hugger Model 500) was applied in preoperative room covering chest, abdomen and both upper and lower limbs. Patients were pre-warmed for around 30 to 45 minutes at the temperature range of 40-42°C. Intermittent communication with the patients during the period of pre-warming was continued and the complaints if any were noted. After the period of pre-warming, the blanket was removed and the patients were shifted to operating room. Pulse rate, blood pressure were noted as pre-induction values. General anaesthesia was given according to the standard practice. Then temperature probe (thermocouple) was inserted in nasopharynx above the soft palate. The core temperature with the other parameters was recorded as 0 min values using multipara monitor. Before preparation of operative part like painting with antiseptic solution and draping with cotton surgical drapes, skin surface warming blanket was applied to the patients in both the groups covering abdomen and lower limb in head and neck cancer surgeries and whole body except head and neck in mandibular and neurosurgeries. The blanket was attached to the warming device (Bair Hugger model 500) which was set in the temperature range of 40-42°C. Ambient temperature was maintained between 20-22°C all throughout the surgery.

Intraoperative monitoring included core body temperature, pulse rate, blood pressure, SpO_2, cardiac rhythm, peripheral nerve stimulation, end tidal CO_2 and blood loss. Appropriate intravenous fluids and blood products were given at room temperature as required. The Decision to extubate the patients was based on criteria that included adequate spontaneous ventilation with maintenance of oxygen saturation and return of airway reflexes as decided by anaesthesiologist. Extubation time (time from termination of anaesthesia to removal of tube from trachea) was noted. Warming blankets were removed immediately after extubation. Patients were observed for signs and symptoms of hypothermia like shivering, piloerection and cold peripheries and treated with active warming, increasing room

temperature and warming intravenous fluids. The recovery score was noted at 15 min, 30 and 60 minutes after extubation using a new 'White PF criteria' (a new fast track scoring system that incorporates the essential elements of the modified Aldrete system, as well as an assessment of pain and emesis) [6] . Patients with delayed recovery were further observed and shifted to ICU. Other complications like bradycardia (PR<60/min) and hypotension (Mean arterial pressure < 20% of the base line) were noted and treated accordingly.

Analysis of Data

The demographic variables were compared by descriptive statistics like mean and percentage. The core temperature and other vital parameters were compared with repeated measure ANOVA using SPSS and trend analysis using graphical method. T test and P value were used for comparing mean extubation time and recovery score.

Results

The demographic data of both the study groups is shown in Table 1. The mean duration of surgery in Group A was 249 min and in Group B 214.50 min, which was comparable. (P value 0.068). Type of surgery was comparable in both the groups Table 2.

Baseline temperature in group A was 36.74±0.2°C and in group B was 36.59±0.2°C. The difference in temperature was not statistically significant (p value 0.06). At 0 minutes the Mean body temperature was 36.34±0.3°C in group A and 36.1±0.4°C in group B, which was comparable (p value 0.072). The body temperature started falling in both the groups from its initial values after induction of anaesthesia. The degree of fall was more in group B. The difference of this fall in temperature between two groups was significant up to 150 minutes. (Figure 1) After 150 minutes, the fall in temperature in both the groups continued till the end of the study period. This difference was not significant statistically. The lowest temperature in group A was 34.87±0.4°C at 330 min and in group B it was 35.0±0.4°C at 300 min which was not statistically significant. The actual difference of fall in core body temperature in both the groups is shown in Table 2. The fall was significantly more in Group B at 60, 90 and 120 minutes (p value 0.008, 0.05 and 0.032 respectively).

Difference in mean pulse rate and mean systolic blood pressure in both the groups were not statistically significant at any point of time. Mean

Table 1: Demographic data

Demographic data	Group A	Group B	P value
Age (years)	44.21	43.85	0.909
Weight (kg)	60.65	59.33	0.565
Sex	15:5	12:8	0.51
M:F	75%-25%	60%-40%	

Table 2: Type of surgery

Type of surgery	Group A	Group B	P value
Head neck cancer surgery	13 (65%)	14 (70%)	0.929
Mandibular surgery	2 (10%)	2 (10%)	0.928
Neurosurgery	5 (25%)	4 (20%)	0.708

Table 3: Fall in temperature at various time intervals

Time (min)	Fall in temperature(°C) Group A	Group B	P value
60	0.385	0.575	0.008
90	0.535	0.660	0.05
120	0.625	0.790	0.032
180	0.805	0.875	0.468
240	1.027	1.000	0.825
360	1.175	-	-

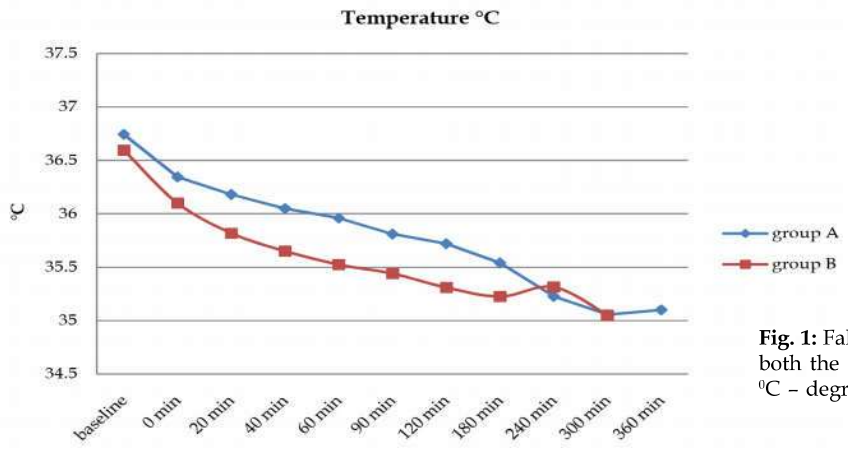

Fig. 1: Fall in temperature at different intervals in both the groups
^{0}C – degree Celsius

recovery score at 15 min, 30 minutes and at 60 minutes after extubation was similar in both the groups. Mean extubation time in Group A was 13.94 minutes and in Group B was 14.44 minutes. It was statistically insignificant (p value 0.183). Two patients in Group A and three patients in Group B had shivering. This difference was not statistically significant (p value 0.633). Only one patient in Group A had nausea. Other complications like cold peripheries, thermal discomfort, hypotension, bradycardia, hypertension and hypoxia were not observed in any patient.

Discussion

The present study entitled 'Comparative study of prevention of hypothermia using preoperative as well as intraoperative forced air warming with only intraoperative warming in patients of surgeries under general anaesthesia' was conducted at a rural based tertiary care hospital. Different studies using different methods for prevention of peri-operative hypothermia have been conducted in the past. Camus Y, Delva E, Cohen S, Lien hart A 1993 [7] studied effects of warming intravenous fluids on intraoperative hypothermia and postoperative shivering during prolonged abdominal surgery. They concluded that infusion of warmed fluids combined with skin-surface warming helps to prevent hypothermia and reduces the incidence of postoperative shivering. Oliver Kimberger et al. [8] studied Resistive Polymer Versus Forced-Air Warming in volunteers and found that heating efficacy and core rewarming rates were similar with full body forced-air and full-body resistive polymer heating. The major cause of hypothermia in most patients given general anaesthesia is an internal core to peripheral redistribution of body heat that usually reduces core temperature by 0.5 to 1.5° C in the first 30 minutes following induction of anaesthesia. Pre-warming increases the temperature of peripheral tissues, limiting the amount of heat lost from the core through redistribution hypothermia. Following induction of anaesthesia, vasodilatation again increases blood flow, but the warmer periphery limits the blood's rate of cooling and allows the blood to return to the core at a higher temperature. So, pre-warming is effective in preventing redistribution hypothermia. Without pre-warming, the intraoperative use of circulating water, forced-air and resistive-heating techniques are often unable to prevent the decrease in core temperature during the first hour of anaesthesia.

The following studies had observed the effect of pre-warming on peri operative hypothermia. Vanni SM et al. [9] conducted prospective, randomized, blind study to compare the effect of pre-warming combined with intraoperative warming and only intraoperative warming on hypothermia in patients undergoing elective laprotomy receiving general anaesthesia. They concluded that one hour of preoperative warning combined with intraoperative skin-surface warming, not simply intraoperative warming alone, avoided hypothermia caused by general anaesthesia during the first two hours of surgery. Both methods prevented postoperative hypothermia and shivering and offered good conditions for early tracheal extubation. Ji Young Kim, et al. [10] studied the effect of skin surface warming during anaesthesia preparation on preventing redistribution hypothermia in the early operative period of off-pump coronary artery bypass surgery. 40 patients undergoing OPCAB were divided into control and pre-warming groups. They concluded that Active warming using forced air blanket before the induction of anaesthesia reduced the incidence and degree of redistribution hypothermia in patients undergoing OPCAB. It is a simple method with reasonable cost, which does not delay the induction of anaesthesia nor the surgery.

In our study, patients in group A were actively warmed pre-operatively with Bair hugger forced air warmer at 42°C temperature for a period of 30 to 45 minutes (mean 39.5 min), as pre-warming for a fixed duration was not possible because of the variation in time of induction in each case. All patients were comfortable during this period. Only one patient complained of thermal discomfort after about 25 minutes of pre-warming, for which the temperature was set at 38°C on Bair Hugger. The optimum duration of effective pre-warming is unknown. Sessler and colleagues [11] estimated 30–60 min to be sufficient, using an FAW device. The landmark study by Just et al. [12] in 1993 showed that 1–2 hours of pre-warming prevented intraoperative hypothermia, even in patients undergoing prolonged abdominal surgery who were not warmed. Subsequently, the optimal duration of pre-warming has been studied. Thirty minutes of full-body forced-air warming in volunteers increased peripheral tissue heat content by more than the amount normally redistributed during the first hour of anaesthesia.

In our study, at 40 minutes, the mean temperature in pre-warming group was 36.05^0C and in non-pre-warming group it was 35.65^0C. Thus the fall of 0.3^0C in first group and 0.45^0C in the other group was statistically significant (p value 0.07). J.

Andrzejowski [1] et al., observed a fall of 0.5°C in pre-warming group and 0.8°C in non-pre-warming group at 40 minutes post induction in patients undergoing general anaesthesia. In our study, the difference between the two groups was >0.2^{0}C at all time intervals from 20 min to 150 min. After 150 minutes, the fall in core body temperature continued in both the groups, but the difference was not significant statistically, which was comparable with the results by J. Andrzejowski et al. [1]. One Multinational, multicenter randomized prospective open-label controlled trial by Alexander Torossian et al. [13] published in 2016, compared the efficacy of new self-warming BARRIER EasyWarm blanket with passive thermal insulation on peri-operative core body temperature in 246 adult patients. Intervention group received prewarming with EasyWarm blankets atleast for 30 min along with intraoperative warming and control group received passive thermal insulation intraoperatively. The BARRIER EasyWarm blanket significantly improved peri-operative core body temperature compared to standard hospital blankets (36.5°C, SD 0.4°C, vs 36.3, SD 0.3°C; p <0.001). Intraoperatively, in the intervention group, hypothermia incidence was 38% compared with 60% in the control group (p =0.001). Postoperatively, the figures were 24% vs 49%, respectively (p =0.001).

Extubation time was taken as the time from termination of anaesthesia to removal of tube from trachea. The mean extubation time in group A was 13.94 minutes while it was 14.44 minutes in group B. Prolonged extubation time was observed in total four patents in our study, two in each group.

In group A, one patient of meningioma and another of cerebral aneurism could not be extubated on table because of their neurological status and were shifted to ICU.

In group B, two patients could not be extubated on table out of which one patient, who was operated for carcinoma of posterior part of tongue developed upper airway edema and another patient operated for cherubism developed soft tissue edema of mandible. However, hypothermia was not observed in any of these four patients at the end of the surgery. All these patients were not included in calculation for mean extubation time and recovery score as the reason for not extubating them was other than hypothermia. Vanni simone maria, Jose Reinaldo, Rosa Beatriz [9] studied that intraoperative skin surface warming prevents intraoperative hypothermia and offers good conditions for early extubation (mean extubation time 14.32 minutes).

In our study we found two cases of post operative shivering in group A (10%) and three cases in group B (15%) with p value 0.633, which was not statistically significant. They were treated with injection tramadol 0.5 mg/kg IV and oxygen with face mask.

Conclusion

- Pre-warming is effective in reducing heat loss for initial 2 to 2.5 hours as compared to only intra-operative warming.
- There is no difference in other secondary parameters like extubation time and post anaesthesia recovery after the surgery of 3 to 6 hours duration.

So, it can be implied that pre-warming has no added advantage over only intraoperative warming in long duration surgeries.

Future Implication

NICE guidelines emphasize the importance of maintaining normothermia even for short procedures and advocate warming patients who are cold before operation [14].

So whether pre-warming done in short duration surgeries helps in improving any of the outcomes can be studied. Other devices for pre-warming are available as bair paws gowns [15], BARRIER easywarm blankets [13], etc. Their effect on patient's comfort level can be studied in specific surgical group.

Limitations of Study

Sample size was small and statistical analysis would be better with larger sample size. Validity of study can be improved by selecting the patients with similar kind of surgical conditions. Though optimum duration of pre-warming is not yet confirmed, many studies suggest pre-warming for 60 to 90 minutes. India being a tropical country, such a long duration of pre-warming was not practically possible in our study.

References

1. J. Andrzejowski, J. Hoyle, G. Eapen and D. Turnbull. Effect of pre-warming on post-induction core temperature and the incidence of inadvertent peri-operative hypothermia in patients undergoing general anaesthesia; British Journal of anaesthesia; 2008(5): 627-31.

2. M Bock; J Muller; A Bach; H Bohler; et al. Effect of preinduction and intraoperative warming during major laprotomy; British journal of anaesthesia; 1998 Feb;80;2:159-163.
3. Marianne Winkler, Ozan Akca, Beatrice Birkenberg, et al. Aggressive warming reduces blood loss during hip arthroplasty; Anesth Analg 2000;91:978-84.
4. Rajagopalan S, Mascha E, Na J, Sessler DI. The effects of mild peri-operative hypothermia on blood loss and transfusion requirement, Anesthesiology. 2008 Jan;108(1):71-7.
5. Lenhardt R., Kurz A., Sessler D.I., Marker E., Narzt E., & Lackner F. Intraoperative hypothermia prolongs duration of postoperative recovery. Anesthesiology; 2003;83(3A):A1114.
6. White PF, Song D. New criteria for fast-tracking after outpatient anaesthesia: a comparison with the modified Aldrete's scoring system. Anesth Analg 1999; 88:1069–72.
7. Camus Y, Delva E, Just B, Lienhart A. Leg warming minimizes core hypothermia during abdominal surgery. Anesth Analg. 1993 Nov;77(5):995-9.
8. Oliver Kimberger et al. Resistive Polymer Versus Forced-Air Warming: Comparable Heat Transfer and Core Rewarming Rates in Volunteers, Anesth Analg 2008;107:1621–6.
9. Vanni SM, Braz JR, Módolo NS, Amorim RB, Rodrigues GR Jr. Preoperative combined with intraoperative skin-surface warming avoids hypothermia caused by general anaesthesia and surgery. J Clin Anesth. 2003 Mar;15(2):119-25.
10. Ji Young Kim, Helen Shinn, Young Jun Oh, Yong Woo Hong, Hyun Jeong Kwak. The effect of skin surface warming during anesthesia preparation on preventing redistribution hypothermia in the early operative period of off-pump coronary artery bypass surgery; Eur J Cardiothorac Surg 2006;29:343-347.
11. Sessler D, Schroeder M, Merrifield B, Matsukawa T, Cheng C. Optimal duration and temperature of pre-warming. Anesthesiology 1995;82:674–81.
12. Just B, Trévien V, Delva E, Lienhart A. Prevention of intraoperative hypothermia by preoperative skin-surface warming Anesthesiology. 1993 Aug;79(2): 214-8.
13. Alexander Torossian, Elke Van Gerven, Karin Geertsen, Bengt Horn, Marc Van de Velde, Johan Raeder. Active peri-operative patient warming using a self-warming blanket (BARRIER EasyWarm) is superior to passive thermal insulation: a multinational, multicenter, randomized trial, Journal of Clinical Anesthesia 2016;34:547–54.
14. Frank SM, Fleisher LA, Breslow MJ, et al. Peri-operative maintenance; Clinical Practice Guideline. The management of inadvertent peri-operative hypothermia in adults. National Collaborating Centre for Nursing and Supportive Care commissioned by National Institute for Health and Clinical Excellence (NICE): April 2008. Available from http://www. nice.org.uk/nicemedia/pdf/ CG65Guidance. pdf.
15. Ricardo Caio Gracco de Bernardisa, Monica Maria Siaulysa, Joaquim Edson Vieirab, Lígia Andrade Silva Telles Mathiasc a; Peri-operative warming with a thermal gown prevents maternal temperature loss during elective cesarean section. A randomized clinical trial, Rev Bras Anestesiol. 2016;66(5):451-55.