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Original Research Article

The role of warmed intravenous fluid on intraoperative hypothermia and postoperative shivering during prolonged oral and maxillofacial surgery

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ABSTRACT

Background: Under general anaesthesia, the core temperature may drop up to 6°C. Patients undergoing prolonged maxillofacial surgery frequently experience unintentional hypothermia that causes postanaesthetic shivering which is a common complication of anaesthesia that should be prevented. This study aimed to evaluate the role of warmed intravenous fluid in preventing intraoperative hypothermia and postoperative shivering.
Methods: Between January 2022 and December 2022, 322 patients with American Society of Anesthesiologists (ASA) physical status I, II and the age group of 18 to 45 years old scheduled for elective major oral and maxillofacial surgery were evaluated under the Department of Anaesthesiology in Dhaka Dental College and Hospital. The patients were grouped into Room Temperature Group and Warmed Fluid Group.
Results: 162 patients received warmed fluid, whereas 160 patients received fluid at room temperature. In Room Temperature Group, there were 89 male and 71 female patients, whereas Warmed Fluid group had 88 male and 74 female patients. At the end of the procedure, the basal core temperature was 36.7±0.2°C in the group receiving warmed fluid versus 35.9±0.2°C in the group receiving fluid at room temperature. The incidence of hypothermia (<36 °C) was much lower in Warmed Fluid Group (n=28, 17.28%) than Room Temperature Group (n=86, 53.75%). Shivering was more common in Room Temperature Group (n = 67, 41.86%) than in Warmed Fluid Group (n = 19, 11.73%) in the postanaesthetic care unit (PACU).
Conclusions: The results of this study suggested that intraoperative hypothermia and postoperative shivering are less common when warmed fluid is infused.

Keywords: Hypothermia, Maxillofacial surgery, Shivering, Temperature

INTRODUCTION

For the treatment of oral pathology associated with pain and infection in healthy, elderly patients who need prolonged oral and maxillofacial surgery, multifunctional balanced anaesthesia monitoring with a team approach has been reported.[1,2] Hypothermia is the most common intraoperative thermal disturbance under general anaesthesia.[3] Hypothermia can occur as a result of extended exposure to a cool operating room temperature and depressed thermoregulatory reaction caused by anaesthesia.[4,5] Many anaesthetic agents also have an effect on vasomotor tone causing peripheral vasodilation and thus increased heat loss. During surgery there is a greater area of the patient exposed to the atmosphere, in addition to which the loss of heat may be increased by

rapid air movement from modern operation theatre ventilation.

Under general anaesthesia, almost all patients experience hypothermia, often by 1-3°C; based on the anaesthetic type and dosage, surgical exposure, ambient temperature and other factors.[6-9] The first hour even had a 1-1.5°C drop in core temperature.[10] This initial hypothermia is followed by a slower, linear decline in core temperature that lasts for two to three hours.[11] Infusion of 1 liter of crystalloid solution at room temperature decrease mean body temperature by approximately 0.25°C.[12] Administration of several liters of IV fluid may thus siginficantly contribute to developing intraoperative hypothermia.

Bimaxillary osteotomies typically take 3 to 4 hours to complete, although may occasionally take up to 6-7 hours.[13,14] Evaporation from inside surgical wounds, infusion of unwarmed intravenous fluid and exposure to a cold environment are all common during surgery. Though, these factors by themselves would not typically result in hypothermia, thermoregulatory mechanisms would typically maintain body temperature in presence of equivalent external stress.[15] The body's subsequent action in maintaining heat following peripheral vasoconstriction is shivering, which is a physiological reaction to exposure to cold.[16] Postoperative shivering is common. In general anaesthesia, postoperative shivering has been reported to occur 20 to 70% of the patients.[17] Hypothermia typically causes shivering. Moreover, it happens also in normothermic patients throughout the intraoperative period.[18]

The positive effects of warmed intravenous fluid to avoid intraoperative hypothermia and postoperative shivering during prolonged oral and maxillofacial surgery have not been previously reported. The purpose of this study is to evaluate the role of warmed intravenous fluid given to the patient to prevent hypothermia and postoperative shivering during prolonged oral and maxillofacial surgeries.

METHODS

This cross-sectional observational study was conducted under the Department of Anaesthesiology in Dhaka Dental College and Hospital from January 2022 to December 2022. A total number of 322 patients with American Society of Anesthesiologists (ASA) physical status I (normal health), II (mild systemic disease) and the age group of 18 to 45 years old scheduled for prolonged oral and maxillofacial surgery were included in this study. The exclusion criteria for this study were patients below 18 years old and above 45 years old, ASA physical status III (severe systemic disease with definite functional limitation), IV (severe systemic disease that poses a continuing threat to life), V (moribund patients not excepted to live for 24 hours with or without surgery), VI (brain-dead patients whose organs are being harvested for transplant), preoperative sublingual temperature ≥38°C, patients taking calcium channel blocker (calcium channel blocker causes drug induced modulation of vascular tone and alteration in intraoperative core temperature).

Patients who met the requirements for inclusion were given written and verbal information about the study and asked whether they would be willing to participate. The day before surgery, sealed, opaque envelopes containing computer-generated random numbers were unsealed to assign patients to Warmed Fluid Group (case group) or Room Temperature Group (control group). All patients who participated in this trial gave informed written consent and the study was approved by the local ethics committee. All the patients were premedicated with diazepam 5 mg 1 hour before surgery. On the scheduled operative day after confirming nothing per oral status intravenous cannulation was done by 18G IV cannula. After preoxygenation induction was done with propofol 2mg/kg body weight and fentanyl 2µgm/kg body weight. Nasotracheal intubation was done by using suxamethonium 2mg/kg body weight. Anaesthesia was maintained with N_2O (66%) in oxygen, isoflurane and vecuronium. Inspired gases were not actively warmed. Crystalloid intravenous fluid was infused by calculating preoperative deficit, intraoperative maintenance fluid, intraoperative blood loss and third space loss according to patient's body weight. For each ml blood loss 3 ml crystalloid solution was used up to transfusion point. Fluids were kept at operating room temperature (i.e. 22°C) before infusion. In control group (n=160) intravenous fluid was infused at room temperature (i.e. 22°C). In Warmed Fluid Group (n=162) intravenous fluid was warmed using an active IV fluid warming system (Blood and fluid warmer AMPIR-01) which delivers normothermic fluid (i.e. 37°C). The tubing was directly connected to the IV cannula without extension and fluid was warmed as soon as the IV cannula was inserted until the end of surgery. In both groups, patient warming system (Warm Touch™ WT 6000-Covidien) was used to provide even airflow at 37ºC inside the blanket covering available skin surface area of the patient to avoid severe core hypothermia. After completion of the surgery reversal was given with neostigmine 0.5mg/kg body weight and atropine 0.02 mg/kg body weight. After recovery patient was sent in postanaesthetic care unit (PACU) and continued the patient warming system until core temperature reached preinduction value.

Ambient Temperature (T) was measured and recorded by a thermocouple thermometer positioned at patient's level. A probe (Tympanic temperature sensor with 400 series thermistor) was positioned adjacent to the tympanic membrane securing with tape and attached to patient monitor system (Intellivue MX450 patient Monitor) to measure core temperature (T). Mean skin temperature (MST) measured from the average of four skin surface temperature site: 0.3 (T chest + T arm) + 0.2 (T thigh + T leg).[19] The arm probe was placed opposite to the infusion

site. All temperature (T) probes were attached to dual channel thermometer of patient monitor system (Intellivue MX450 patient Monitor). Just after induction temperature was recorded which was initial value. Then at 15 minutes interval temperature was recorded until core temperature returned to this initial value during postoperative period along with other vital parameters. Shivering was evaluated at 10 minutes interval by an independent observer blinded to the treatment during recovery period. Shivering was graded on a five-point scale as follows.

Table 1: Scoring of postanaesthetic shivering[20].

Grade	Clinical Signs
0	Absence of shivering
1	Fasciculation of lips and facial region
2	Fasciculation of facial and Neck region
3	Visible involuntary movement of two or more muscle groups
4	Gross involuntary muscular activity of whole body.

Mean body temperature (MBT) was calculated as: MBT = (0.66 × T core) + (0.34 × MST).[21,22] Changes in total body heat content (ΔTBHC) were expressed in kilojoules (kJ) as: ΔTBHC = ΔMBT (ºC)×body weight (kg) × 3.48 (kJ/kg/ºc) where ΔMBT is the change in mean body temperature during surgery and 3.48 kJ/kg/ºc is the specific heat of human body.[21] The preservation of heat due to warmed IV fluid was expressed as the difference in intraoperative body heat content changes between two groups.

All the statistical analysis were performed using SPSS (Statistical Packages for Social Sciences) version 23.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

This study was conducted in the period of January 2022 to December 2022 in 322 patients between the age of 18 to 45 years who were scheduled for prolonged oral and maxillofacial surgery under the Department of Anaesthesiology in Dhaka Dental College and Hospital. The patients were grouped into Room Temperature Group and Warmed Fluid Group where 160 patients received fluid at room temperature and 162 patients received warmed fluid. Among them 89 male and 71 female patients were in Room Temperature Group, 88 male and 74 female were in Warmed Fluid Group. All of them had the criteria of ASA class I and II.

In terms of physical characteristics, duration of anaesthesia, total opioid dose, intraoperative ambient temperature, total amount of IV fluid infusion the two groups did not vary significantly from one another (Table 2). In both groups, skin temperature under the warming blanket was 34.5±0.3 ºC after one hour of skin warming and then remain stable until end of the surgery. After one hour, the skin temperature of the unwarmed parts of the body reached 32.3±0.3 ºC and remained unchanged throughout the procedure in both groups. ($p<0.05$ versus skin T under the warming blanket).

Table 2: Characteristics of the two groups of patients (n=322).

Variables	Room temperature group (n=160)	Warmed fluid group (n=162)
Age (in year)	45±3	47±2
Gender (Male/Female)	89/71	88/74
Weight (in kg)	65±4	68±3
Height (in cm)	167±2	166±3
Basal core temperature (°C)	37.0±0.1	36.9±0.1
Operating room temperature (°C)	22±1	22±1
Duration of anaesthesia (min)	390±35	365±38
Infused fluid (L)	3.4±0.3	3.2±0.3
Infusion rate (ml . kg^{-1} . h^{-1})	7.9±0.3	7.2±0.3

Mean±SD; no significant difference between groups

In Room Temperature Group core temperature declined for the first two hours and remained stabilize, while in Warmed Fluid Group core temperature declined for the first 1.5 hours of anaesthesia then remained stabilize and after 30-45 minutes the core temperature was increased (Figure 3). Core temperature was significantly greater in Warmed Fluid Group than in Room Temperature Group after 1.5 hours of anaesthesia. In Warmed Fluid Group the core temperature was 36.7±0.2 ºC and in Room Temperature Group the core temperature was 35.9±0.2 ºC at the end of the procedure ($p<0.05$). The intraoperative decrease in core temperature was 0.2±0.2 ºC in group receiving warmed fluid and 1.1±0.2 ºC in Room Temperature Group ($p<0.05$).

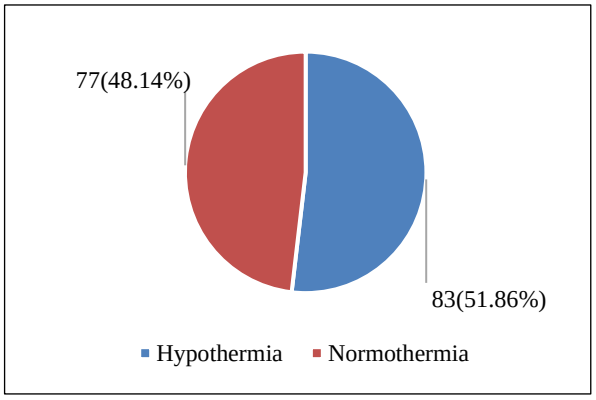

Figure 1: Hypothermia at the end of the surgery in room temperature group.

In Warmed Fluid Group the intraoperative heat loss was 30.76±28 (P<0.05) and in Room Temperature Group heat loss was 165.13±49 (P<0.05). The estimated reduction in heat loss produced by warmed IV fluid was 134.37 kJ.

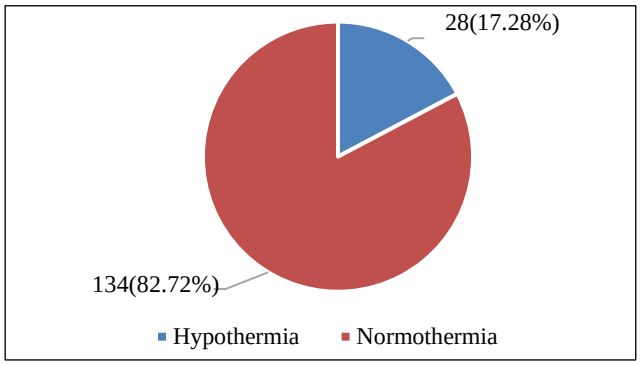

Figure 1: Hypothermia at the end of the surgery in warmed fluid group.

Table 2 shows the characteristics of the two groups of patients. According to age 45±3 years was in Room Temperature Group and 47±2 years was in Warmed Fluid Group. Among the patients 89 were male and 71 were female in Room Temperature Group and in Warmed Fluid Group, 88 were male and 74 were female. Weight and height of patients in Room Temperature Group were 65±4 kg and 167±2 cm whereas patients in Warmed Fluid Group the weight and height were 68±3 kg and 166±3 cm respectively. In both groups operating room temperature was 22±1ºC. In Room Temperature Group the duration of anesthesia was 390±35 minutes while in Warmed Fluid Group it was 365±38 minutes. The amount of infused fluid and infusion rate was nearly same in both groups which was 3.4±0.3L, 7.9±0.3 $ml.kg^{-1}.m^{-1}$ and 3.2±0.3L, 7.2±0.3 $ml.kg^{-1}.m^{-1}$ in Room Temperature Group and Warmed Fluid Group; respectively.

Table 3: Comparison of postoperative data between room temperature group and warmed fluid group.

	Total (n=322)	Room temperature group (n=160), 49.69%)	Warmed fluid group (n=162, 50.31%)	P value
Postoperative shivering n (%)				
Without shivering	236 (73.30)	93 (58.13)	143 (88.27)	<0.05
With shivering	86 (26.70)	67 (41.87)	19 (11.13)	
Intensity of postoperative shivering (Table: I) n (%)				
0	236 (73.29)	93 (58.12)	143 (88.27)	<0.05
1	18 (5.6)	10 (6.25)	08 (4.94)	
2	24 (7.45)	19 (11.88)	5 (3.09)	
3	28 (8.6)	23 (14.38)	5 (3.09)	
4	16 (8.69)	15 (9.38)	1 (0.62)	
Length of PACU stay (hour)				
Mean±SD	1.47(±2.33)	1.77(±3.07)	1.25(±1.47)	
Min-max	0-22.50	0.07-22.50	0-20.17	
Median	1.08	1.17	1.07	

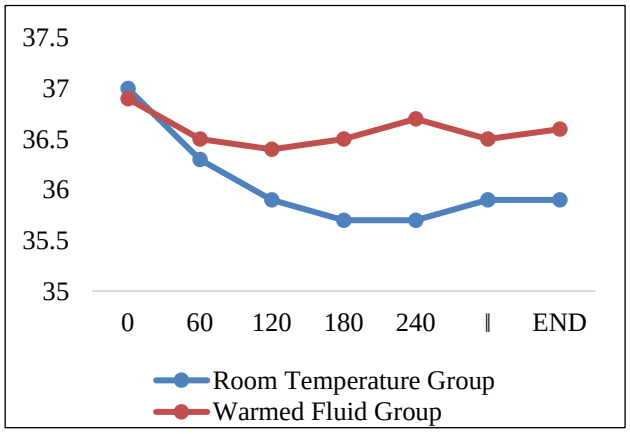

Figure 3: Intraoperative changes in core temperature.

Table 3 shows the comparison of postoperative data between Room Temperature Group and Warmed Fluid Group. Among 322 patients of both groups who participated in this study, a total number of 86 (26.70%) patients developed postoperative shivering in which 67 patients were from Room Temperature Group and 19 from Warmed Fluid Group. Intensity of postoperative shivering was recorded and mentioned according to Table 1 which shows only 1 patient developed grade 4 shivering from Warmed Fluid Group whereas in Room Temperature Group 15 patients developed grade 4 shivering. The length of postanaesthetic care unit (PACU) is more in Room Temperature Group (i.e., 1.77±3.07 hours) than in Warmed Fluid Group (i.e., 1.25±1.47 hours).

DISCUSSION

Postoperative shivering is one of the potentially adverse outcomes of intraoperative core hypothermia. This study has demonstrated the clinical effectiveness of using warmed fluid for prevention of hypothermia and postoperative shivering. The total 322 patients participated in this study were randomly allocated into two groups-Room Temperature Group (control group) and Warmed Fluid Group (case group). A high American Society of Anesthesiologists (ASA) score, the degree of invasiveness of a surgical operation and surgery lasting more than two hours are all potential causes for hypothermia in human.[23]

Patients undergoing major oral and maxillofacial surgery are frequently anaesthetized for prolonged period which encourage secondary hypothermia. It is normal for patients to experience a reduction in core body temperature during prolonged oral and maxillofacial surgery under general anaesthesia, but this should be avoided at all costs because it may have detrimental physiological effects.[24] The loss of peripheral vasomotor control (sympathetic tone) with the ensuing peripheral vasodilation is a key physiological factor contributing to hypothermia during anaesthesia. As a result, during the earliest stages of heat loss, temperature from the body core is transmitted to the periphery (body surface).[25,26]

Shivering after surgery is a potentially significant consequence of hypothermia that raises oxygen consumption proportional to intraoperative heat loss.[27] Warmed intravenous fluid was used to conserve body heat. In this study, intravenous fluid was infused at 37°C through a blood and fluid warming system which significant alleviated perioperative core temperature and postoperative shivering. The warm fluid should be given at the start of anaesthesia to maintain body temperature; they should not be used to raise body temperature in a patient who is hypothermic. After prolonged surgery, the patients were practically normothermic due to the heat gain brought on by warmed fluid, which caused a mean increase in core temperature of 36.7±0.2°C in the group receiving warmed fluid compared to the control group.

A cool operating room temperature, body exposure, the evaporation of disinfectant solutions and infusion of intravenous fluid at room temperature to patients undergoing general anaesthesia for prolonged oral and maxillofacial surgery can all result in unintentional hypothermia. As a result of postoperative shivering, cardiac adverse events, coagulopathy and perioperative hypothermia can impede the quick healing process in this regard.[28-30] It is simpler to avoid physiological issues before they arise, as with all phases of anaesthesia.

The present study was conducted in a very short period due to time constraints and funding limitations. The small sample size was also a limitation of the present study.

CONCLUSION

In conclusion, the Warmed Fluid Group had significantly lower rate of hypothermia (<36 °C) and shivering after surgery. Infusion of warmed fluid combined with skin surface warming helps to prevent intraoperative hypothermia and reduce the incidence of postoperative shivering in patients having prolonged oral and maxillofacial surgeries.

Recommendations

This study can serve as a pilot to much larger research involving multiple centers that can provide a nationwide picture, validate regression models proposed in this study for future use and emphasize points to ensure better management and adherence.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Ethics Committee of Dhaka Dental College Hospital, Dhaka

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