Original Research Article

Routine Intraoperative Forced-Air Warmer Usage in Prevention of Perioperative Hypothermia: To Use or Not to Use in Daycare Breast Lumpectomy?

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Abstract

Intraoperative active warming in daycare surgery may be least popular compared to major elective surgeries due to the lesser risk of perioperative hypothermia. This prospective, single blind, randomized, controlled trial in daycare breast lumpectomy was done to evaluate the routine use of intraoperative forced-air warmer in the presence of other warming modalities in prevention of perioperative hypothermia. Fifty patients were randomized into two groups; Group 1 received forced-air warmer and Group 2 received a standard cotton thermal blanket. Both groups received circulating-water mattress. Intraoperatively, all patients received pre-warmed intravenous fluid with an in-line warmer. Ear and ambient temperature was recorded using infrared ear thermometer and digital thermo-hygrometer respectively. Measurement was done before induction, every 15 minutes intraoperatively, upon arrival in recovery room and 30 mins later, postoperatively. All patients were normothermic prior to induction of anaesthesia. During the initial half an hour post-induction, both groups mean core temperature decreased at approximately 0.6˚C. Both showed no statistical difference in mean core temperature (0.04 ˚C) within the initial half an hour. The next half an hour, both groups had approximately 0.2 decrement but this time, Group 2 had a slightly higher mean core temperature than Group 1 which maintained until the end of surgery. Overall, within the initial one hour post-induction of GA, there was a drop of 0.7˚C and 0.6°C in Group 1 and Group 2 respectively, however the difference in final mean core temperature between the two groups was 0.05°C and it was not statistically significant (p value < 0.05). None of the patients experienced intraoperative hypothermia (< 36˚C) and all remained in the normothermic range with no shivering or sense of feeling cold, postoperatively. The results of the present study found no significant difference in the changes of final core temperature with or without the usage of intraoperative forced-air warmer in the presence of other warming measures in daycare breast lumpectomy.

Keywords: Perioperative hypothermia, forced-air warmer, daycare, intraoperative, lumpectomy

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Introduction

Normothermia is described as 'core' (hypothalamic) temperature that ranges between 36°C to 38°C (1). Core temperature of less than 36°C is considered hypothermia and can be further classified as mild, moderate and severe with a temperature range of 35°C to 35.9°C, 32°C to 34.9°C, and 28°C to 31.9°C, respectively (1,2). Up to 60% of patients experience some degree of hypothermia during surgery (3).

Perioperative hypothermia may lead to serious adverse outcomes such as coagulopathy, increased blood loss (4), perioperative cardiac events, surgical site infections and prolonged hospitalization in major or prolonged surgery (5). Less serious adverse outcomes such as thermal discomfort (sense of feeling cold), post-anaesthesia shivering and delayed discharge from the recovery room (6,7) can be avoided in minor or daycare surgery if adequte perioperative warming measures are practised which will prepare the patient for "home readiness" and eventually translate into better patient satisfaction post-operatively.

Induction of general anaesthesia (GA) impairs the hypothalamic thermoregulatory system in the body which manifests as core temperature change in three stages. The first stage occurs after induction of GA where the body heat are redistributed from core-to-peripheral allowing a mixture of warmer core blood with the less warm peripheral blood. Within the first hour of GA, there will be a sharp decrease of 1.0 to 1.5°C of the core temperature and this is when the patient loses the most heat during surgery (8).

Second stage is regarded as a slower process and occurs within the next two to three hours of GA. This is when the body heat loss exceeds the body heat production. The final and third stage occurs within the next three to four hours after GA where the core temperature started to plateau indicating that the heat loss equals the heat production (9).

Numerous risk factors can predispose patients to perioperative hypothermia, such as cool ambient operating room temperatures, prolonged exposure after skin preparation, surface area of the surgical site, duration of surgery, general anaesthesia, central neuraxial anaesthesia, infusion of cold or inadequately warmed intravenous fluids, open thoracic surgery, major abdominal surgery and the extreme ages of patients. Therefore, there are various approaches to prevent perioperative hypothermia. The circulating-water mattress (10,11,12) and forced-air warming system (10-19) has been available for decades by which it actively warms the patient perioperatively with majority of published papers favouring forced-air warmers in terms of efficacy. To date, there are few more active warming devices such as the circulating-water garment (14,15,16), carbon resistive-heating system (15,17), radiant warming system (18) and electric heating pad (19) with few being comparably efficacious and non-inferior than the forced-air warmer. There are also conventional or passive warming methods such as pre-warmed cotton blankets, socks, limited skin exposure, head covering and reflective blankets (1).

In our facility, forced-air warmer and circulating-water mattress are used commonly and routinely in daycare surgery to prevent perioperative hypothermia despite the lack of temperature monitoring which should be performed ideally. However, forced-air warming device may not be available for all daycare surgery rooms as opposed to circulating-water mattress due to few reasons such as limited purchase of the device unit or consumables by the hospital, device malfunction secondary to multiple and frequent handling or being utilized by a more prolonged surgery. It is a known fact that the first stage of hypothermia during GA contributes the largest drop in core temperature, hence daycare surgery patients which has a duration of anaesthesia within one to two hours are selected for the purpose of this study. The present study aimed to evaluate the need of a routine use of intraoperative forced-air warmer in daycare surgery in the presence of other warming modalities in prevention of perioperative hypothermia (< 36°C).

Materials and Methods

This was a prospective, single blinded, randomized controlled study conducted from April 2009 until June 2010, approved by Ethics and Research Committee Universiti Kebangsaan Malaysia Medical Centre (UKMMC). A written informed consent was obtained from 50 patients with American Society of Anesthesiologists (ASA) physical status I and II, aged between 18 to 60 years old underwent breast lumpectomy in daycare surgery. Exclusion criteria were pregnancy, preoperative fever (core temperature more than 38°C) or preoperative temperature of less than 36°C, intraoperative temperature of more than 37.5°C, GA lasting more 90 mins, Body Mass Index (BMI) of less than 18 kg/m^2 and and more than 25 kg/m^2 and those with otologic disease.

A computer generated table of random numbers (generated from the website www.randomization.com) was used to randomize patients to either Group 1 (control group) who received lower body warming blanket (Bair–Hugger Model 525; Augustine Medical, Eden Prairie, MN) connected to Bair–Hugger Warming Unit Model 505 (set at 38°C) with the other non-surgical field of the body surface covered with standard cotton thermal blanket or Group 2 (experimental group) received a standard cotton thermal blanket covering the non-surgical field of the body surface. Patients from both groups were placed on a full length circulating-water mattress (Gaymar-Medi-Therm II, Gaymar Industries, New York) covered with a single cotton sheet. The circulating-water mattress was started 10 mins prior to the induction of GA and were maintained

throughout surgery with a temperature set point of 38°C.

The ambient operating theatre (OT) temperature was maintained at the range of 19°C to 21°C centrally. In which was continously measured and recorded every 15 minutes with a digital thermo-hygrometer (Sato, Model PC-5000TRH-II) positioned away from any heat-generating equipment, at the same level as the patient but not further than 50 cm from the patient. Patient's core temperature was measured using an ear thermometer (BraunThermoscan IRT 4020, Germany) with an infrared radiation capability.

Intravenous fluid were pre-warmed at the set temperature of 41°C in a warming cabinet and an in-line warmer (Elltec Animec, AM-2S Fluid Warmer) was used. All patients were monitored via standard non invasive blood pressure, pulse oximeter, electrocardiogram and capnogram monitoring. GA was induced with intravenous (IV) Fentanyl 1.5 µg/kg and IV Propofol 2 mg/kg. Laryngeal mask airway inserted and anaesthesia was further maintained using Sevoflurane (2%) in air: oxygen mixture. Heat-moisture exchangers were used in the respiratory circuits. Measurement of core and ambient temperatures prior to induction was designated as time zero and were simultaneously recorded throughout the surgery at 15 mins interval after induction of GA.

For intraoperative breakthrough pain, IV Fentanyl 1µg/kg was given accordingly and IV Parecoxib 40 mg was given at approximately half an hour before surgery ended. Five to 10 ml of Levobupivacaine (Chirocaine) 0.5% was infiltrated at the surgical wound at the end of surgery. After patients were awakened and laryngeal mask airway was removed, all were transferred to recovery area with a standard cotton thermal blanket.

In the recovery area, all patients received full body length blanket (Bair–Hugger Model 300) connected to Bair–Hugger Warming Unit Model 505 (set at 38°C) until they are fully awake and transferred to an armchair in the step-down unit. Core and ambient temperature were recorded upon arrival and at 30 mins post-arrival in recovery room. The recovery room ambient temperature was measured by another digital thermo-hygrometer (Sato, Model PC-5000TRH-II) which was placed before the start of each case.

All perioperative mean core temperatures and ambient temperatures were measured and recorded by either the primary investigator, other anaesthetic trainee, GA staff nurse or recovery room staff nurse. Same digital thermo-hygrometer (2 units) and ear thermometer (1 unit) was used throughout this study. Techniques of using the ear thermometer were demonstrated and observed by the primary investigator to maintain accuracy and competency. Every measurement recorded was either witnessed by the primary investigator, other anaesthetic trainee, GA staff nurse or recovery room staff nurse. This study was not blinded due to size of the device and noise once it is turned on prior to induction of GA. However, observer who measured and recorded the core temperature in the recovery room, was unaware of the patient randomization as all patients received forced-air warmer postoperatively in the recovery.

A total sample size of 50 patients were calculated in order to detect a clinical difference of 0.5°C in final core temperature between two groups, with a beta error of 10% (power = 0.9) and an alpha error or significance level of 5% (p value < 0.05). Statistical analysis was performed using Statistical Package for Social Sciences (SPSS version 16.0 Chicago, IL) software. Quantitative variables were reported as mean ± standard deviation (SD) or as numbers with percentage (%) where appropriate. Changes in core temperature over time during each treatment were evaluated with the Wilcoxon Signed Ranks test. Independent T-test was used to compare the differences between treatments at each time interval.

Results

Fifty patients were randomized into Group 1 and Group 2. The demographic and anthropometric data (Table 1) data of both groups were comparable in terms of age, BMI and ASA physical status with all being female patients. The perioperative data (Table 2) showed a majority of cases presented with single fibroadenoma meanwhile multiple fibroadenoma were more in Group 1 (12 % vs. 4%). However, other profiles in terms of duration of anaesthesia and surgery revealed minimal difference between the 2 groups.

In the present study, all patients were normothermic (Table 3) prior to induction of GA with a mean core temperature of 36.8 ± 0.3°C in Group 1 and 36.7 ± 0.3°C in Group 2.

Figure 1 showed that during the initial half an hour post-induction, both groups comparably had a modest drop in mean core temperature at approximately 0.5°C. Both showed no statistical difference in mean core temperature (0.04°C) within the initial half an hour. The next half an hour, both groups had approximately 0.2°C decrement but this time, Group 2 had a slightly higher mean core temperature than Group 1 (36.2°C vs 36.1°C) which maintained until the end of surgery. Overall, within the initial one hour post-induction of GA, there was a drop of 0.7°C and 0.6°C in Group 1

Table 1: Demographic data. Values are expressed as mean ± standard deviation (SD) and numbers with percentage (%).

	Group 1 (with forced-air warmer) n = 25	**Group 2 (no forced-air warmer) n = 25**
Age (yrs)	33.16 ± 12.30	31.36 ± 12.07
BMI (kg/ m^2)	21.57 ± 2.20	21.80 ± 1.97
Ethnic		
Malay	72 %	64 %
Chinese	20 %	32 %
Indian	0 %	4 %
Others	8 %	0 %
ASA Physical Status		
I	92 %	88 %
II	8 %	12 %

Table 2: Perioperative data. Values are expressed as mean ± standard deviation (SD) and numbers with percentage (%).

	Group 1 (with forced-air warmer) n = 25	**Group 2 (no forced-air warmer) n = 25**
Breast lump		
Single	88 %	96 %
Multiple	12 %	4 %
Anaesthesia time (min)	59.8 ± 19.6	66.0 ± 23.0
Surgery time (min	42.2 ± 16.4	49.4 ± 21.8

Table 3: Perioperative mean core temperature (˚C) between each group. Values expressed as mean ± SD.

	Group 1 (with forced air warmer) n = 25	**Group 2 (no forced air warmer) n = 25**	***p* value**
Intraoperative core temperature			
T0	36.82 ± 0.32	36.78 ± 0.30	0.946
T15	36.61 ± 0.30	36.56 ± 0.48	0.150
T30	36.34 ± 0.44	36.30 ± 0.60	0.334
T45	36.21 ± 0.57	36.27 ± 0.61	0.929
T60	36.14 ± 0.55	36.20 ± 0.67	0.612
T75	36.27 ± 0.07	36.28 ± 0.42	0.952
Postoperative core temperature			
T0	36.29 ± 0.43	36.25 ± 0.54	0.795
T30	36.51 ± 0.24	36.55 ± 0.32	0.615

Intraoperative; T0: time prior to induction, T15: 15 mins post induction, T30: 30 mins post induction, T45: 45 mins post induction, T60: 60 mins post induction, T75: 75 mins post induction.

Postoperative; T0: time upon arrival to recovery room, T30: 30 mins in recovery room.

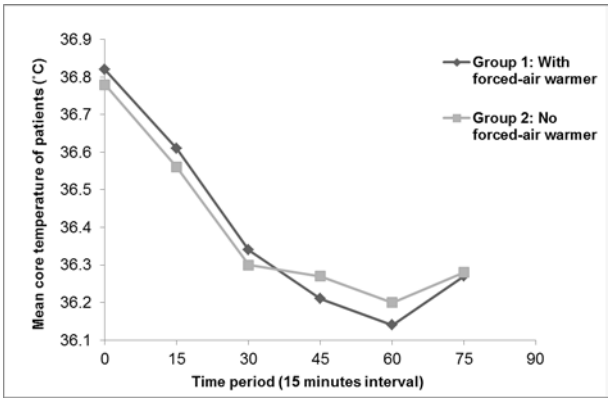

Figure 1: Perioperative mean core temperature (°C) profile of the forced-air warmer group and no forced-air warmer group.

and Group 2, respectively. However, the difference of final mean core temperature between the two groups was 0.05°C and it was not statistically significant (p value < 0.05).

Beyond one hour post induction, both groups showed no further decrease and reached comparable final mean core temperature of 36.2°C. Perioperatively, none of the patients experienced intraoperative hypothermia (< 36°C) and all remained in the normothermic range post-operatively with an increase of mean core temperature of approximately 0.3°C in the recovery room. Upon monitoring and questioning in the recovery room, only one patient complained of sore throat which was not related to perioperative complications of hypothermia, hence reassurance was given to the patient. None of the patient experienced shivering or complained of 'cold'. All of them were able to be transferred to an armchair in the step-down unit after half an hour monitoring in the recovery room.

Discussion

There will be a decrease of approximately 1.0 to 1.5°C during the first hr after induction of anaesthesia and it is the most important cause of intraoperative hypothermia during GA (8). This initial phase of thermoregulatory impairment develops due to the reduction of vasoconstriction threshold, internal redistribution and rapid core-to-peripheral transfer of heat. Similarly, this study showed the decrease in mean core temperature during the first hr of post-induction of GA despite the presence of active warming devices (forced-air warmer, circulating-water mattress) and other warming measures (pre-warmed fluids, in-line warmer).

Based on our results, intraoperative mean core temperature changes and patterns were comparable between both groups but unexpectedly after half an hour post induction, Group 2 (without forced-air warmer) had mean core temperature slightly higher than Group 1 (with forced-air warmer). However, both groups remained normothermic throughout the surgery. Bamgbade et al. (2007) did a retrospective review and detected a high prevalence of mild preoperative hypothermia (32%) in ambulatory surgical patients by which usage of intraoperative forced-air warmer reduced perioperative hypothermia but showed no significant effects on blood pressure and oxygen saturation. Presence of mild preoperative hypothermia had a modest effect haemodynamically as they are relatively healthy patients (20). Patients in both groups of this study had physical status of ASA I to II which reflects a relatively healthy group of patients undergoing breast lumpectomy.

In this study, none of the patient needed to be pre-warmed actively as the holding bay ambient temperature was approximately between 24°C to 25°C prior to being wheeled to the operating theatre (OT). Pre-operatively, all patients in this study were normothermic and standard cotton thermal blanket was applied to maintain normothermia at the pre-induction period. The current recommendation for prevention of perioperative hypothermia is active pre-warming for at least 30 mins on the basis of Class IIb/ Level B evidence (1,21-24). This can be done by active warming with forced-air warmer prior to induction of anaesthesia. It works by attenuating the redistribution hypothermia through an induced vasodilation and a reduced core-to-peripheral temperature gradient that occurs during the initial phase of thermoregulation in the anaesthetized patients (25). Not implementing pre-warming may render the usual observed initial sharp temperature drop after the induction of anaesthesia if there is lack of warming measures perioperatively (23).

The only similarity in terms of active warming that both of these group had was the presence of circulating-water mattress intraoperatively. Circulating-water mattress is a form of active conductive warming which comprises of a mattress incorporated with a circulating heated water via a hose. It is placed on the operating table and temperatures can be set and turned on prior to surgery providing heat underneath the patient during surgery. Meanwhile, another generation of circulating-water system i.e. circulating-water garment has the same concept but comprises of a blanket which can be wrapped around the extremities or trunk. Another form or circulating-water system is the hydrophilic gel-filled "adhesive energy transfer pad" which delivers heated water and can be placed on the thighs and abdomen (26). Taguchi et al. (2004) found that there was more heat transferred from the circulating-water garment mainly

due to the large posterior body heating as compared to forced-air warmer during first hour of warming. Circulating water re-warms patients at a more rapid rate of 0.4°C/hour compared to forced-air warmer due to the intrinsic ability of water to transfer heat better than air. It was also quoted that a combination of forced-air warmer and circulating-water mattress would have a similar profile with circulating-water garment in terms of body warming and rate of heat transfer (14). This is supported by another study done by Wadhwa et al. (2007) where they compared the efficiency of heat transfer between two circulating water system (energy transfer pad vs circulating water garment) and the forced-air warmer in a simulated upper abdominal or chest surgery. They found that during the first hour of GA, the energy transfer pads had a faster increment of core temperature than the circulating-water garment by 25% and twice faster compared to forced-air warmer as the efficacy depends on the part of the body which was heated and the portion of surface area accessible for heating (27).

Pagnocca et al. (2009) had also demonstrated that during the initial first hour of post-induction of GA, the mean core temperature for those with conductive warming system (circulating-water mattress) had a higher mean core temperature compared to those with combination of warming system (circulating-water mattress and forced-air blanket). They stated that the main element which can prevent perioperative hypothermia is the quantity of heat being delivered and transferred to the patient (11). Galvão et al. (2010) performed a meta-analysis of different types of active warming (forced-air warming, circulating-water garment, radiant warming system, resistive-heating system) and eventually concluded that circulating water garment system is more efficacious in maintaining normothermia in patients than the forced-air warming system (28). It has been mentioned that the main determinant behind its efficacy is the barrier property (plastic thickness of the warming system) separating the water and skin, effective skin contact with the system and the degree of skin perfusion. Besides that, the design of the garment has to be sufficient to cover most of the intended warming area as compared to forced-air warmer which have a more dynamic airflow property for greater skin coverage (16). American Society of PeriAnesthesia Nurses (ASPAN) published a comprehensive guideline to promote perioperative normothermia and suggested that many alternative methods of warming measures can be implemented, either used alone or combined with forced-air warmer to maintain normothermia. These are the circulating-water mattress (Class IIb/Level B) circulating water garment (Class IIb/Level B), resistive heating (Class IIa/Level B), radiant heating (Class IIb/Level B) and warmed intravenous fluids (Class IIa/ Level B) (1).

Forced-air warmer has been available since the 1980's and it is a form of warming system in which the heat is transferred across the anterior portion of the skin surface into the peripheral thermal compartments. It comprises of a warming unit that circulates heated air through a specially designed commercial blanket making it inflated on the anterior surface of the intended warming area. This blanket can be placed either on the upper, lower or the whole body (29). The body can roughly be divided into two thermal compartments, namely the core thermal compartment (head and trunk) and peripheral thermal compartment (limbs) (8). The time for the heat to flow from peripheral to core thermal compartment can be prolonged or delayed depending on the individual vasomotor status (30). Therefore, the ability of intraoperative convective warming (forced-air warmer) can be hindered by the short duration of surgery. This is evident in the study conducted by Pagnocca et al. (2009) where only after one hour post-induction of GA, patients assigned with the combination of warming system (circulating-water mattress and forced-air blanket) group who started of being hypothermic managed to be warmed and achieved normothermia till the end of surgery. While those assigned with conductive warming system (circulating-water mattress) who started of being normothermic during the initial one hour post-induction of GA, later developed hypothermia till the end of surgery (11). Hasegawa et al. (2012) compared circulating-water leg wraps and circulating-water mattress against forced-air warmer and carbon-fiber resistive-heating, all groups demonstrated hypothermia within one hour of induction of GA due to a significant drop of temperature. However, in subsequent hours, the mean core temperature in the circulating-water group increased while those with forced-air warmer and resistive-heating showed minimal change. This is also explained by the extra posterior heating provided by the circulating-water mattress which speeds the warming process. In relation to forced-air warmer's design, it does not provide that extra heating at the posterior or dependent surface of the body, hence the efficiency is lesser. However, the forced-air warmer has a good safety record as compared to circulating water system and resistive heating system (15). This conforms to the trend of mean core temperature profile we displayed in our study, where the usage circulating-water mattress may have contributed to the efficiency of active warming instead of the forced-air warmer within the first hour of GA.

Despite the water being a good medium for heat transfer in active warming for prevention of perioperative hypothermia, previous studies had reported that convective warming (forced-air) remains to be more efficacious in surgeries lasting more than 1 hr as

compared to other available methods such as circulating-water system, resistive-heating system, radiant heating and electric heating pad (10-19). This is contributed by the reactivation or re-emergence of thermoregulatory peripheral vasoconstriction in the subsequent hours of GA in those who are effectively warmed and well insulated intraoperatively (26). ASPAN and NICE (National Institute for Health and Clinical Excellence) guidelines has also suggested that forced-air warming (Class I/ Level A) should be implemented in patients who are evidently or at risk (extremes of age, BMI below normal) of hypothermia and those undergoing an anticipated surgery of more than 30 minutes (1,22). Other warming methods like resistive heating works principally by a heat build-up driven by low electrical current either in the carbon fiber or polymer-filled reusable blanket which can be used in different parts of the body. However, the rate of warming is less efficient than the forced-air warmer (15,17). Radiant warming systems works by radiating or transferring the heat through light to the anterior surface of the patient's face and extremities. Kadam et al. (2009) compared the efficiency between the forced-air warmer and the radiant warmer in elective laparoscopic cholecystectomy and found no significant difference in the temperature difference intraoperatively (18).

Intravenous (IV) fluid warming has been proven to be an important adjunct of heat preservation besides active warming especially when the surgery involves a large amount of intravenous fluids. It helps to reduce and minimize the magnitude of perioperative hypothermia (31). A unit of refrigerated blood or room temperature crystalloid (1 L) given to a patient, may reduce mean body temperature by 0.2 to 0.4°C (32,33). When added to the ongoing heat loss from the skin surface, problems associated with the unwarmed fluids can be compounded. IV fluid warming in ambulatory or daycare surgery is just as important and relevant as in major surgery. Kim et al. (2014) demonstrated that patients who received pre-warmed fluids (approximately 41°C) in the presence of circulating-water blanket, they remained normothermic throughout the perioperative period as compared to those who received fluids at room temperature in ambulatory urological surgery under monitored anaesthesia care (MAC). In relation to the pharmacokinetic profile of the commonly used drugs in MAC (propofol, midazolam) which has vasodilatory effect even at sedative doses, the thermoregulatory changes associated with MAC may mimic those shown in GA but at a lesser degree within the first hr of induction (34). Andrzejowski et al. (2010) demonstrated that pre-warmed fluid for at least 8 hrs had a comparable efficiency as the fluid delivered via an in-line warming system if it is given within 30 mins upon retrieval from the warming cabinet in adult patients undergoing day-case surgery that lasted less than 30 mins with no other warming measures are being implemented. They were also able to demonstrate lesser percentage of postoperative hypothermia in those who received warmed fluids either pre-warmed or in-line warmer group compared to those that received fluids at room temperature (35). Charles et al. (2006) found that a combination of convective warming (forced-air warmer) and intravenous fluid warming was more efficacious compared with routine thermal care at maintaining perioperative normothermia besides reducing the incidence and severity of postoperative shivering in ambulatory surgery of more than 30 minutes (31). In this study, all patients were given pre-warmed fluid as well as an in-line warming system with the average amount required were 500 to 1000 ml.

Obese patient tends to maintain a steady intraoperative body core temperature better than the non-obese patient due to the presence of protective fat layer. Kasai et al. (2003) demonstrated that obese patients redistribute less body heat and have a higher thermoregulatory vasoconstrictive threshold, hence spending most of their time being vasodilated intraoperatively. Conversely, very thin patients redistribute heat more in low ambient temperature (36). Therefore, this was the reason that only patient's with BMI of 18 to 25 kg/m^2 were included in this study so that the results would not be misleading.

The "gold standard" equipment for core temperature recording has been proven and suggested to be the tympanic membrane thermocouple. It is known that the tympanic membrane has a close proximity to the brain which shares the same vascular supply as the hypothalamus and the site is easily accessible, therefore it is considered as one of the almost ideal site for core temperature measurement in clinical practice (3,8,10,15,20,26,27,31,33,34,35). However, insertion of a fixed temperature probes in the auditory canal has its risk of damage, as the tympanic membrane is thin and easily wounded.

An alternative to a fixed probe, intermittent aural canal temperature measurement by using an infrared thermometer is quite reasonable and practical as it does not pose the previously mentioned risk. Therefore, we have chosen infrared thermometer to measure core temperature at the tympanic membrane despite knowing it would be a methodological limitation for this study. Matsukawa et al. (1996) compared four commercially available infrared tympanic thermometers in Japan (Genius®, Thermopit®, Quickthermo®, Thermoscan®) with the thermocouple (Mon-a-Therm®). Generally, they had concluded that most of them are suitable to be utilized for core temperature measurement during short

surgical procedures (37). Infrared thermometer is quite simple to use but still requires appropriate conduct to attain an accurate reading in which a single operator is preferable.

The average duration of surgery and anaesthesia time in this study was approximately 1 hr despite it being a single or multiple breast lumps upon presentation in both groups. There were few influencing factors identified through this study that led to the comparable surgical and anaesthesia time. These were due to the varying experience and skill of the trainee Surgeons performing the breast lumpectomy and types of breast lumps. This study focused only on daycare breast lumpectomy for standardization and homogeneity reasons as it only includes women and did not involve any men as there were none presenting with breast lump during the period of data collection. The applicability of these data to other procedures and ambulatory/daycase surgery remains to be confirmed.

Conclusion

This study concluded that routine usage of forced-air warmer in the presence of other warming measure had no significant effect on the changes of final core temperature in daycare breast lumpectomy. Overall patient satisfaction was not compromised with or without forced-air warmer usage.

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