Comparison between Forced Air and Intravenous Fluid Warmer in Gynecologic Laparoscopic Surgery: A Randomized Trial

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Abstract

Background:

Peri-operative hypothermia is a common problem in anesthesia. Investigators would like to compare the difference between core and room temperature in patients undergoing gynecologic laparoscopic surgery by using forced air and intravenous fluid warmer.

Material and Method:

After IRB approval COA: Si201/2016, the study has been registered at ClinicalTrials.gov NCT02990429. A prospective experimental study was conducted with 90 patients. All participants were randomized into two groups: A receiving intra-operative forced air warming and B having intra-operative intravenous fluid via a fluid warmer. Core and room temperatures were measured at 15-minute interval until the end of surgery. The data was expressed as means and standard deviation. The p-value less than 0.05 was considered statistical significance at 95% Confidence Interval.

Results:

The 86 patients accomplished the trial. Temperature of both groups showed to decrease insignificantly after induction, but it appeared a slightly lower in group B as compared to group A. In addition, group A showed a little higher temperature than that of group B in the recovery room.

Discussions:

Bair Hugger seemed to be an effective warming technique. However, the forced air warmer yielded a circulating flow only on the upper part of patient's torso. As a result, the body heat could easily loss from its remaining part. On the other hand, as a patient was in lithotomy position with both arms laid aside the trunk and the whole body was draped over at the beginning of surgery, an anesthetist had to use a long extension for intravenous fluid management. Thus, the warmed fluid lost warmth en route through the patient. Therefore, the distance between source of fluid and site of needle cannulation should be short as much as possible. Consequently, this generated a troublesome in intra-operative fluid administration. In addition, the fluid flow rate played a role in bodily heat control; as the slower the rate was, the lower the temperature would be.

Conclusion:

The forced air warmer was clinically effective than the fluid warmer in gynecologic laparoscopic surgery.

Keywords:

hypothermia, gynecologic laparoscopic surgery, general anesthesia.

Introduction

Peri-operative hypothermia is a common problem in anesthesia. It has been defined as a core temperature below 36ºC[1]. The reasons why patient undergoing gynecologic laparoscopic surgery has this adverse event, are reduced metabolic heat production, heat redistribution from the core to the periphery, impaired thermoregulation, cool carbon dioxide gas insufflation, surgical irrigation solution, and cool environment[2]. Consequently, the sequelae are myocardial ischemia as hypothermia increases plasma catecholamine, surgical site infection as hypothermia diminishes wound tissue O_2 tension and coagulopathy as hypothermia impairs platelet function[3-6].

Studies claim that peri-operative heat loss occurs by radiation (60%), convection (25%) and evaporation (10%)[7]. These are due to the difference between peripheral body and ambient temperature, air circulation around the body and vasodilatation.

In daily practice, most anesthesia personnel warm patient peri-operatively by using force air warmer and/or intravenous fluid warmer. Thus, investigators would like to compare the difference between core and room temperature in patients undergoing gynecologic laparoscopic surgery by using forced air and intravenous fluid warmer.

Materials and Methods

The Siriraj Institutional Review Board approved the study COA: Si201/2016, and written informed consent was obtained from all subjects. Study setting was registered at ClinicalTrials.gov NCT02990429. The study was conducted at the Department of Obstetrics and Gynecology, Siriraj Hospital.

A total of 90 patients were enrolled in the study: 84 patients for calculated sample size, and 6 patients for dropout purpose. All patients underwent general anesthesia for elective gynecologic laparoscopic surgery. Inclusion criteria were patients aged between 18 and 65, elective case, ASA physical status class I--III, BMI 25-30 kg/sq.m., surgical time > 90 minutes. Exclusion criteria were the core temperature less than 35ºC or more than 38ºC. Withdrawal or termination criterion was the change of laparoscopic surgery to exploratory laparotomy.

On the day of surgery, participants signed the informed consent and were randomized equally into two groups: A = 45, receiving intra-operative forced air warming (Bair Hugger, Arizant Healthcare Inc., St. Eden Prairie, USA) and B =45, having intra-operative intravenous fluid via a fluid warmer (Ranger Warmer, Augustin Medical, Inc. Prairie, USA).

After application of standard monitors, anesthesia was induced intravenously with fentanyl 1-2 mcg/kg or morphine 0.1-0.2 mg/kg, propofol 1.5-2.5 mg/kg, cisatracurium 1-1.5 mg/kg or atracurium 0.6 mg/kg. Anesthesia was maintained with sevoflurane, air, O_2 supplemented with fentanyl or morphine. Core temperatures were measured with an electronic thermometer via tympanic membrane.

Intra-operatively, core temperatures and room temperatures were measured at 15-minute interval until the end of surgery.

Postoperative data were measured at 15-minute interval at the recovery room. Data consisted of vital signs, core temperature, room temperature, shivering, medication requirements and use of heating devices.

Group A, the warming blanket was applied on the upper part of body after induction of anesthesia. The forced air was delivered at the high setting of 43ºC. At the end of anesthesia, the blanket was removed and the patient was delivered to the recovery room with standard care. Group B, patients received intravenous fluid via a fluid warmer after induction of anesthesia. The device automatically heated fluid up to 41ºC as set point. At the end of procedure, the fluid warmer was disconnected and the patient was transferred to the recovery room with intravenous fluid administered at room temperature.

Patient developing intra-operative core temperature greater than 37.5ºC had to quit all devices to avoid hyperthermia.

Statistical analysis:

Using non-dependent t-test and Chi-square test compared parametric and nonparametric data respectively. The parametric ones expressed as means and standard deviation. The p-value less than 0.05 was considered statistical significance at 95% Confidence Interval.

Results

The 86 patients accomplished the trial, while 4 patients were excluded from the study because of the failure of room temperature device.

Both groups (A = 44, B = 42) were insignificant difference with respect to age, body mass index, ASA status, fluid balance, irrigation fluid, type and duration of surgery, core and operating room temperature (Table 1).

Temperature of both groups showed to decrease insignificantly after induction (Figure 1), but it appeared a slightly lower in group B as compared to group A. In addition, group A had insignificantly higher temperature at 15, 30, 45, 60, 75, and 90 min interval than that of group B (Table 2).

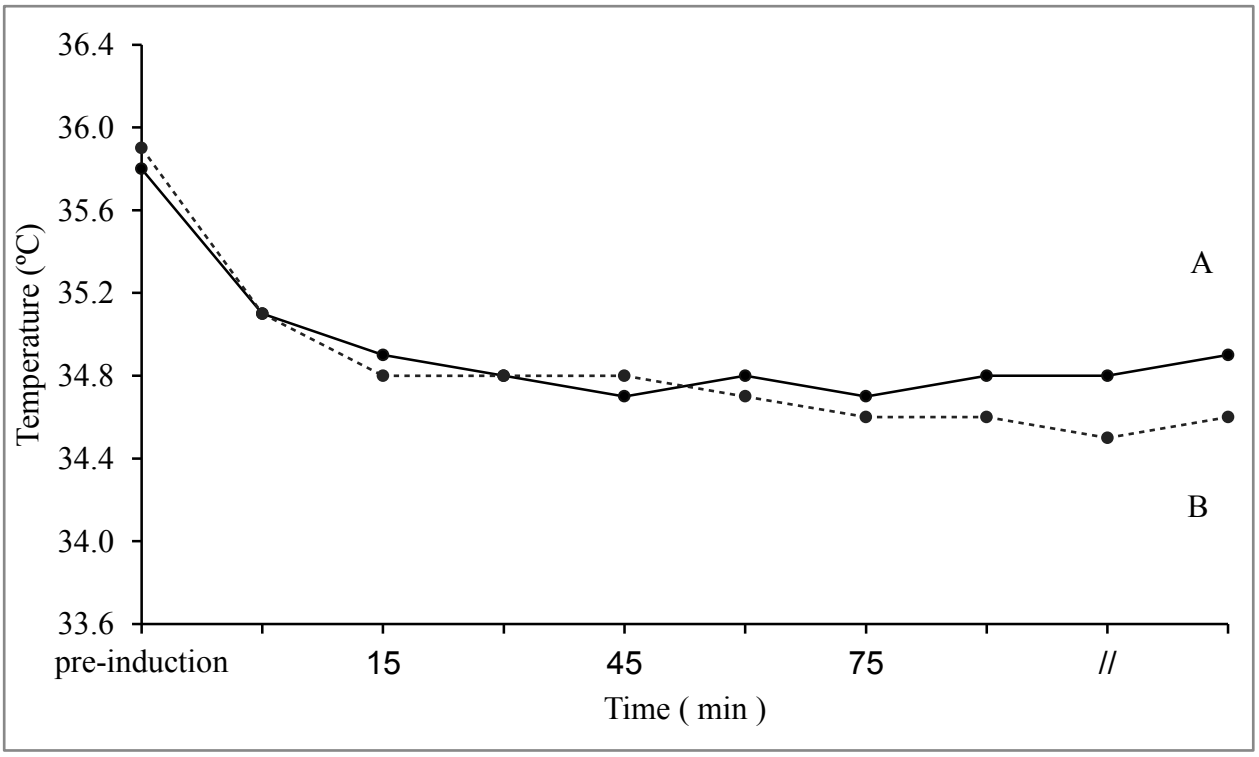
After 15 minutes of arrival in the recovery room, group A showed a little higher temperature than that of group B (Figure 2). Afterwards, there were no differences in temperature between the two groups (Table 3).

Four patients in group B and one patient in group A had mild shivering without the needs of any treatment such as opioids or warmed blankets (Table 4).

Table 1. Patients' characteristics (group A: Bair hugger, group B: Ranger warmer)

	Group A (N = 44)	Group B (N = 42)	p
Age (yrs)	46.1 ± 6.2	46.0 ± 6.2	0.946
BMI (kg/m2)	27.0 ± 1.7	26.8± 1.8	0.678
Type of surgery:			
TLH, BSO	15 (34.1%)	10 (23.8%)	-
TLH	18 (40.9%)	24 (57.2%)	-
Lap.Myomectory	3 (6.8%)	4 (9.5%)	-
Oter	8 (18.2%)	4 (9.5%)	-
ASA physical status:			
I	23 (52.3%)	22 (52.4%)	-
II	20 (45.4%)	18 (42.9%)	-
III	1 (2.3%)	2 (4.7%)	-
Core Temperature preoperative (ºC)	36.6 ± 0.4	36.6 ± 0.4	0.895
Core temperature pre - induction (ºC)	35.8 ± 0.6	35.9 ± 0.6	0.833
Operating theatre temperature (ºC)	23.5 ± 1.1	23.5 ± 1.2	0.704
Surgery time (min)	166.0 ± 57.1	170.7 ± 49.0	0.684
Fluid balance (ml)	984.1 ± 505.4	957.1 ± 382.3	0.782
Irrigate water (ml)	756.8± 552.1	833.3 ± 633.0	0.551

Figure 1. Intra-operative mean temperature in patients receiving forced air warming (Bair hugger) and intravenous fluid warmer (Ranger warmer).



A : Forced air warming (Bair hugger)
B : Intravenous fluid warmer (Ranger warmer).

Table 2. Intra-operative core and room temperature between the two groups (mean ± SD)

Core temperature	Group A	Group B	p
0 minute	35.1 ± 0.8	35.1 ± 1.2	0.905
15 minute	34.9 ± 1.0	34.8 ± 1.1	0.689
30 minute	34.8 ± 1.0	34.8 ± 1.0	0.692
45 minute	34.7 ± 1.1	34.8 ± 1.0	0.826
60 minute	34.8 ± 1.1	34.7 ± 1.0	0.561
75 minute	34.7 ± 1.0	34.6 ± 1.0	0.483
90 minute	34.8 ± 1.0	34.6 ± 1.0	0.333
Room temperature	Group A	Group B	p
0 minute	23.0 ± 1.1	23.0 ± 1.2	0.998
15 minute	22.9 ± 1.0	22.8 ± 1.3	0.717
30 minute	22.7 ± 1.1	22.7 ± 1.2	0.803
45 minute	22.6 ± 1.0	22.6 ± 1.2	0.838
60 minute	22.5 ± 1.0	22.4 ±1.3	0.673
75 minute	22.4 ±1.0	22.3 ± 1.3	0.748
90 minute	22.3 ± 1.0	22.3 ± 1.1	0.817

Figure 2. Post-operative mean temperature at the recover room in patients receiving forced air warming (Bair hugger) and intravenous fluid warmer (Ranger warmer).

A : Forced air warming (Bair hugger).

B : Intravenous fluid warmer (Ranger warmer).

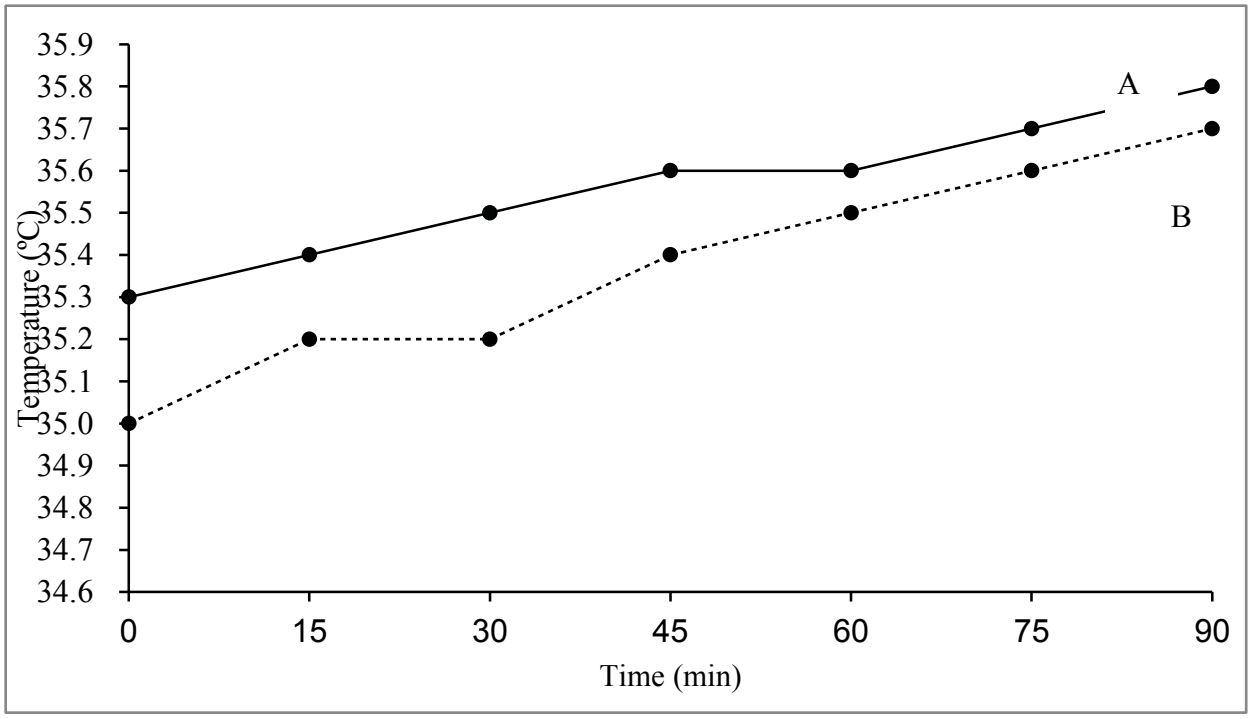


Table 3. Post-operative core temperature between the two groups (mean ± SD)

Core temperature	Group A	Group B	p
0 minute	35.3 ± 0.7	35.0 ± 0.9	0.108
15 minute	35.4 ± 0.7	35.2 ± 0.8	0.240
30 minute	35.5 ± 0.7	35.2 ± 0.8	0.109
45 minute	35.6 ± 0.7	35.4 ± 0.7	0.284
60 minute	35.6 ± 0.7	35.5 ± 0.7	0.612
75 minute	35.7 ± 0.7	35.6 ± 0.7	0.486
90 minute	35.8 ± 0.7	35.7 ± 0.6	0.475

Table 4. Post-operative treatment for shivering.

Recovery room	Group A	Group B
Warm blankets	1 (2.3%)	5 (11.9%)
Pethidine	0	0

Discussion

The demographic characteristics of both groups were similar. After 15 minutes of induction, group A and B insignificantly showed to decrease in temperature and appeared to maintain at steady stage throughout the procedure, with a slightly higher in group A.

The forced air warmer seemed to be an effective warming technique. Feroe, et al. supported this in a study on effectiveness of convective warming therapies in the PACU[8]. In addition, Adriani, et al. claimed that conventional intra-operative forced-air warming still offered benefit[9]. However, the decreasing of temperature might due to the warmer at the high setting of 43ºC, yielded a circulating flow only on the upper part of patient's torso. As a result, the body heat could easily loss from its remaining part. This also mentioned in the study performed by Wagner, et al[10].

Therefore, if the forced air warmer used to apply all over patient's body, it could have alleviated heat loss efficiently. Apparently, Bernthal, et al. and many other researchers confirmed that the device was the most effective means to prevent hypothermia and suggested to use it routinely[11-13].

On the other hand, as a patient was in lithotomy position with both arms laid aside the trunk and the whole body was draped over at the beginning of laparoscopic procedure; an anesthetist had to use a long extension tube for intravenous fluid management. Thus, the warmed fluid at the set point of 41ºC, lost warmth en route through the patient. Therefore, in a cool

operating theatre, the distance between source of fluid and site of needle cannulation should be short as much as possible.

Consequently, this generated a troublesome in intra-operative fluid administration. In addition, the fluid flow rate played a role in bodily heat control; as the slower the rate was, the lower the temperature would be. These findings agreed with Faires, et al. who performed a study on the relationship between temperature to distance and flow rate of warmed intravenous fluids in pediatrics[14] and Person, et al. who concerned about the large volume of fluid relative to patient size and suggested a slow rate infusion[15]. Moreover, Rein, et al. stated that warmed water with pulsating negative pressure was better than forced air warmer[16] and Turner, et al. in a study on simulated clinical evaluation of fluid warming devices, revealed that in order to achieve temperature close to 37ºC, the flow rate at 150 ml/min was needed[17].

Interestingly, Seo, et al. suggested that the deceasing rate of temperature was related inversely to the flow rate and directly to the catheter length. Accordingly, it might need a rapid infusion pump with adequate heating system at a high flow rate and locate the warmer close to patient for reserving a heating effect[18].

In the recovery room, all participants were covered by warmed blanket; while, the core temperature of both groups showed insignificant difference. However, the forced air warmer seemed to keep body warmed longer than that of the fluid warmer. This agreed with Patel, et al. who reported that patients receiving convective warming were more likely to leave the operating room normothermic, and had higher central temperature during the first 30 min in the recovery room[19].

Conclusion

The forced air warmer was clinically effective than the fluid warmer in gynecologic laparoscopic surgery.

What is already known on this topic?

Currently, most anesthesia personnel prevent patients from hypothermia by using forced air and/or intravenous fluid warmer during gynecologic laparoscopic surgery. Forced air

warming system are claimed to be effective in preventing peri-operative hypothermia and shivering. However, the increasing number of intravenous fluid warmer usage is still questionable on its effectiveness.

Suggestion of further study

Regarding the effectiveness of intravenous fluid warmer, the distance between the fluid and the site of intravenous cannulation are of concern, other than the rate of fluid administration.

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