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A prospective comparative study between prewarming and cowarming to prevent intraoperative hypothermia in spinal anaesthesia

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ABSTRACT

Introduction: Temperature is one of the important parameter to be monitored in anaesthesia. Regional anaesthesia impairs thermoregulation as in general anaesthesia. There are several studies comparing different techniques to prevent intraoperative hypothermia. This study was done to compare the effect of prewarming and cowarming in preventing intraoperative hypothermia after subarachnoid block in cesarean section. *Methods*: A Prospective comparative study was conducted in a tertiary care hospital, 100 patients were enrolled and they were divided into 2 groups of 50 each, Group X (Prewarming) –Patients were pre warmed before induction in pre operative room. It was done by setting the temperature to 40◦C for 30 minutes. Group Y (Cowarming) - Patient were warmed as soon as the patient is shifted to the operating room using forced air warming blanket. Core temperature (rectal temperature) and the peripheral temperature (axillary temperature) were measured before induction and intraoperatively and incidences of shivering in both groups were studied. *Results*: It was observed that Pre warming the patient reduced the rate of fall of temperature compared to cowarming group but, there were no significant difference in measurements between the two groups, with mean (SD) final rectal temperatures of 36.6(1.8)◦C with group X and 35.9(1.1)◦C with the group Y. The incidence of shivering observed in Group X was 8.3% and in Group Y was 14%. *Conclusion*: Warming the patient preoperatively along with intraoperative warming reduces hypothermia compared to only intraoperative forced air warming blanket. But, there is no significant difference between the two groups. Only cowarming is as effective as pre warming.

Keywords: Hypothermia, Cowarming, Prewarming, Intraoperative warming, Spinal anaesthesia.

1. BACKGROUND

Temperature is one of the important parameter to be monitored in anaesthesia because hypothermia is considered as one of the most common complication in perioperative period. Neuroaxial anaesthesia greatly impairs autoregulation and induces vasodilation by inhibiting vasomotor and shivering responses, promoting thermal transfer from the core to peripheral tissues which in turn can lower core temperatures up to 1.6° C (Matsukawa *et al.*, 1995; Gurunathan et al., 2017). With higher dermatomal spread in spinal anesthesia there is increased risk of hypothermia (Frank *et al.*, 2000). In addition, spinal anaesthesia is not always associated with severe thermal discomfort, despite mechanisms that remain unclear in patients experiencing core hypothermia. Spinal anaesthesia blocks tonic cold sensory feedback to thermoregulatory centres from the lower limbs, which can be experienced by patients as relative warmth (Sessler et al., 2016). A perioperative core temperature of 36° C is known as inadvertent perioperative hypothermia (IPH). Inadvertent perioperative hypothermia occurs due to different mechanisms like metabolic heat production, heat loss from operation theatre environment or impaired thermoregulation (Andrzejowski *et al.*, 2008). Hypothermia has negative impact on postoperative course causing shivering, increased discomfort; wound infection, high risk of coagulopathy, increased risk of blood loss, myocardial ischemia, and prolonged hospital stay (Butwick et al., 2007).

Core to peripheral redistribution of heat is not easy to treat (Hynson et al., 1992). Moreover intraoperative hypothermia can be prevented by various techniques like giving warmed intravenous fluids intra operatively, forced air warming pre-operatively and intraoperatively, warming the operating room, and also various opioids has been tried intravenously and intrathecally (Allen et al., 2018). Prewarming has been shown to raise the temperature of the peripheral tissue and reduce the core temperature gradient to the temperature of the peripheral tissue (Becerra *et al.*, 2019). There are studies comparing prewarming and co warming to prevent intraoperative hypothermia after general anesthesia but no such studies has been conducted comparing prewaming and co warming after neuroaxial blockade.

This study will be done to compare the techniques of prewarming and cowarming in preventing intraoperative hypothermia, also compare core to peripheral temperature gradient and to study the incidence of shivering in prewarming and co warming

2. MATERIALS AND METHODS

This is a Prospective comparative study which was conducted in a tertiary care hospital in JNMC, sawangi after ethical committeee clearance. Referring to previous article Butwick et al., (2007), Sample size calculation was done using a software openepi, keeping power at 80% and confidence intervals at 95% (alpha error at 0.05) sample of 96 patients were required, considering possible dropouts 100 patients were enrolled 50 of each group. Participants consort flow diagram is shown in figure 1, in which patients were randomized into two groups.

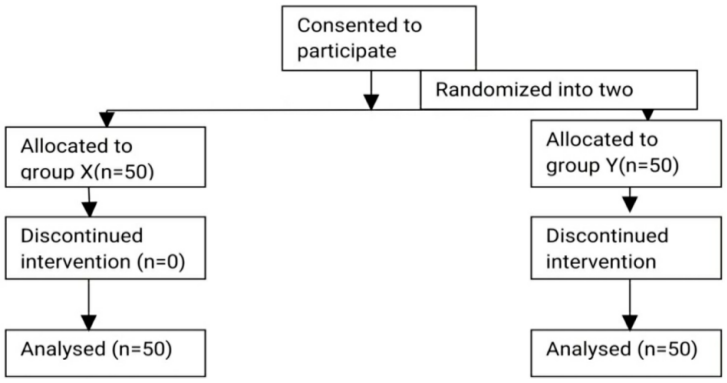

Figure 1 Consort flow diagram of two study groups.

Inclusion criteria were American society of anesthesiology (ASA) physical status I and II term pregnant women with 38-42 weeks of gestation, aged between 18 to 40 years, BMI of 18.5 to 25kg/m^2 patients posted for elective cesarean section under SAB of ≤2 hrs. We excluded patients suffering from any endocrine disorders like thyroid disorders, diabetes mellitus, patients affected with peripheral vascular disease, hemodynamicaly unstable patients, patients with baseline temperature above 37.5°C. Patients fulfilling inclusion criteria were randomly divided by using computer generated random number table into two groups of 50 each. Group X – group pre-warming and Group Y- group co-warming. In all patients 18G venous cannula was secured in forearm, Rectal and

axillary temperature was measured using thermometer as Baseline core and peripheral temperature is measured in preoperative room for all patients.

In group X –patients were pre-warmed for 30 minutes in pre operative room before the induction of spinal anesthesia using forced air warming blanket covering the whole body except the face. Pre-warming is done by setting the temperature to 40◦C for 30minutes. Both group received 500ml of Ringer lactate which was stored at room temperature in the preoperative room. Inj. ondansetron and Inj. Metoclopromide was given to all pateints irrespective of NMB status, opioids were avoided. After shifting the patients inside operation theatre pulseoximetry, electrocardiography and automated non invasive blood pressure monitor was attached. I.V fluid was infused at room temperature. Sub arachnoid block was performed using 25 G quincke's needle, using 0.5% inj. Bupivacaine (heavy) in L2-L3 space in sitting position by an anesthesiologist not involved in the study. No adjuvents were added. Immediately after spinal anesthesia patient was given supine position with wedge over left side to prevent supine hypotension syndrome (Howard et al., 1953).

After achieving T6 level, core and peripheral temperature was recorded. Before commencement of surgery in both the groups forced air warming blanket was placed over the patient's lower limbs and attached to the warming device (40^{O}C) without disturbing the surgical field and upper part of the body were actively warmed using blankets. After induction once the level is achieved core and peripheral temperature is taken and recorded. Warming will be continued in the intraoperative period. In the pre-warming group, patients were removed from the study if there was a delay of >15 minutes from the end of the pre-warming to shifting the patient to the operating room (Shenoy *et al.*, 2019). Operating room temperature was maintained at 24◦C (Morris et al., 1971).

Core and peripheral temperature will be measured in the pre operative room, after induction and at the end of the surgery. Based on core body temperature, the severity of hypothermia will be graded as follows Lohsiriwat, (2019): Normothermia-36°C - 38°C

32.2 °C–35 °C as moderate hypothermia

28 ° C-32.2 ° C as Mild hypothermia

<28 °C as severe hypothermia

Crossley and Mahajan Mittal (2014) graded shivering, No shivering as grade 0, if there is piloerection, peripheral vasoconstriction but without visible muscle activity one or more of this as grade 1, if there is Visible Muscle activity in only one muscle group it is graded as grade 2, if there is visible muscle activity in more than one muscle group but no generalized shaking it is graded as grade 3 and gross muscle activity that involves entire body as grade 4. In case if patients develop shivering then as a rescue method temperature was increased from 40^{o}C to 45^{o}C, if not reduced then Inj. Tramadol 1mg/kg IV was given. A trained pediatrician who is blinded to our study assessed the APGAR score of neonate.

Statistical analysis

It was performed using version 20 of SPSS. In order to interpret the findings, the independent sample t-test, Mann-Whitney U-test and Fisher's exact test to interpret the results. The P value <0.05 was observed to be statistically important.

3. RESULTS

A total of 100 patients (50 in pre warming group and 50 in co warming group) were enrolled in this study between December 2019 to June 2020. The demographic data of both the groups were similar and there was no significant difference among the two groups (Table 1). All the vital parameters such as non-invasive blood pressure, peripheral oxygen saturation, heart rate were monitored; there was no significant difference between the two groups. The pre-operative and operation theater room temperature were similar in both the groups (Table 2). Surgical and Anesthetic characteristics like level of sensory block, total duration of surgery, total fluids infused and total blood loss were documented (Table 2) and there was no significant difference between the two groups. There was no subarachnoid block failure or surgery related complications observed in our study.

Table 1 Demographic Data

	GROUP X (n=50)	GROUP Y (n=50)
Age (yrs)	31.8(4.6)	31.8(3.9)
BMI(kg/m^2)	22.07(1.76)	22.56(1.67)
Height(cm)	158.6(6.1)	156.3(5.4)

Table 2 Spinal anaesthesia and surgery related data

CONFOUNDING FACTORS	GROUP X	GROUP Y
Pre Operative room temperature(°C)	23.9±1.7	24.2±1.6
Operating room temperature(°C)	24.0±1.9	24.3±1.5
Level of sensory block: T4 T6	 18 12	 17 13
Duration of surgery	43.1±8.2	45.8±7.3
Infused fluids	1240±369	1420±360
Total blood loss	574±283	540±220

The peripheral temperature decreased in group Y compared to group X, (-0.7±0.5°C vs -1.2±0.7°C) (Table 3 and Figure 2). Similarly, core temperature also decreased in group Y compared to group X (-0.7 ± 0.8°C vs -1.2 ± 1.3°C) (Table 4 & Figure 3) but the rate of fall between two group was not statistically significant. The incidence of shivering (Table 5) was 8.3% in pre warming group and 14% in co warming (p=0.32) which was comparable. In prewarming group because of shivering 3 pateints needed increase in temperature of warming blancket and 1 received Inj. Tramadol 1mg/kg IV, and in co warming group 2 pateints received inj. Tramadol 1mg/kg IV as rescue analgesia and in 5 patients shivering reduced by increasing temperature from 40-45°C. We assessed Apgar scores at 1 and 5 min; we noted no differences in neonatal outcome.

Table 3 Changes in peripheral temperature in Group X and Group Y

Peripheral temperature	Group X	p value	Group Y	p value	p value
Baseline(°C)	36.2(1.7)		36 (1.6)		0.64
After Induction(°C)	35.8(1.5)	0.337	35.3(1.1)	0.0531	0.14
At the end of surgery (°C)	35.5(1.2)	0.07	34.8(0.9)	0.0001*	0.058

*p value of <0.05, when compared with group X

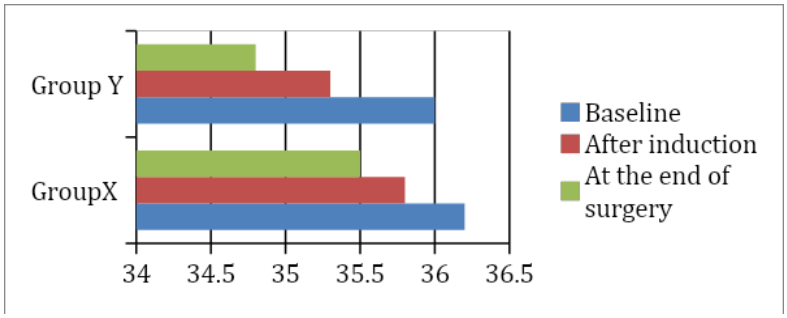

Figure 2 Changes in peripheral temperature in Group X and Group Y

Table 4 Changes in core temperature in Group X and Group Y

Core temperature	Group X	p value	Group Y	p value	P value
Baseline(^{O}C)	37.3(2.6)		37.1(2.4)		0.75
After Induction(^{O}C)	36.9(1.9)	0.49	36.4(1.7)	0.19	0.28
At the end of surgery (^{O}C)	36.6(1.8)	0.23	35.9(1.1)	0.015*	0.074

*p value of <0.05, when compared with group X

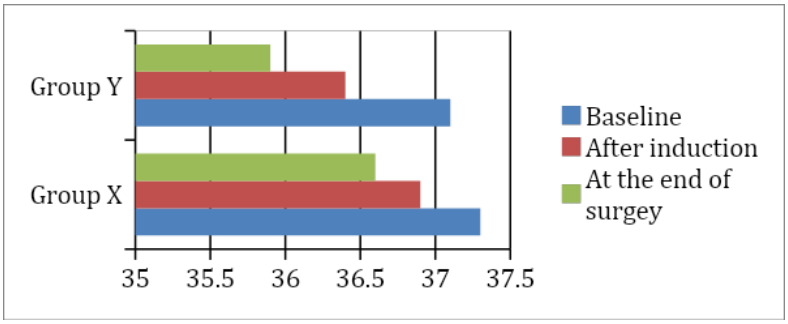

Figure 3 Changes in core temperature in Group X and Group Y

Table 5 Maternal and neonatal study data

Maternal study data :	Pre warming (n=50)	Co warming (n=50)
Shivering score>1	4(8.3%)	7(14%)
Nausea	3(6%)	2(4%)
Vomiting	1(2%)	1(2%)
Neonatal outcomes :		
Apgar 1 min	9(8-9)	8(7-9)
Apgar 5 min	9(8-9)	9(8-9

4. DISCUSSION

In this study, we compared pre warming and co warming techniqes to prevent intraoperative hypothermia. Preoperative warming of the patient did not cause significant fall in core temperature as compared to only intra operative warming of the patient. However, there was no significant difference between prewarming the patient 30 minutes prior to surgery and only intra-operative warming using forced air warming blanket. In this study we have choosen pre- operative warming time as 30 minutes based on previous studies (Butwick et al., 2007; Hynson et al., 1992). Different studies used different duration for prewarming, Angel becerra et al.,(2019) studied the effectiveness of prewarming on perioperative hypothermia submitted to spinal anesthesia, in his study he pre warmed patients for different duration 15 mins, 30 mins and 45 mins and he found that there was no benefit observed when prewarming lasted for 45mins. In advertent perioperative hypothermia can have an impact over outcome of surgery and post operative course (Torossian et al., 2015; Melling *et al.*, 2001). Following spinal anaesthesia hypothermia occurs because of few mechanisms which impair the thermoregulation major cause being core to peripheral redistribution of heat mainly in the 1st hour of neuroaxial block (Gurunathan et al., 2017). It is difficult to treat hypothermia by warming alone once the core temperature falls Sessler*et al.*,(1995).In our study we observed that there is reduction in the incidence of hypothermia and shivering in patients undergoing elective caesarean section under spinal anesthesia with prewarming combined with intraoperative warming which is in agreement with other studies.

Chung et al., (2012) studied the effect of preoperative forced air warming and warmed intravenous fluid during cesarean section under spinal anesthesia and found that they prevented core hypothermia and shivering. The possibilities of temperature loss during shifting the patient from pre operative room and during minor procedures like securing vascular access were minimized (Bindu et al., 2017). Pre operative room temperature and operating room temperature were standardized to minimize their influence on our study (Hakim *et al.*, 2018). Morris et al., (1971) in his study on operating room temperature said if the OR temperature is reduced less than 21 ◦ C then the frequency of hypothermia increases rapidy. So, in our study we maintained the pre operative room temperature and operative room temperature between 21-24^{O}C.

We studied only pateints posted for elective caeserian section to make the sample size more homogenous in term of physical characteristics of the patient. One of the main parameter predisposing the patient to hypothermia is the level of sensory block (Frank *et al*., 2000; Leslie *et al*., 1996). On the contrary, Szmuk *et al*., (1997) in his study showed that Residual spinal anesthesia, which maintained lower body vasodilation, significantly increased the rate of core rewarming. Saito *et al*., (1998) showed in their study that in spinal anesthesia thermoregulation was impaired more than epidural anesthesia. Since, spinal anesthesia blocked sensory input better than epidural anaesthesia. The use of warmed IV fluid intraoperatively has been shown to improve perioperative core temperature (Smith et al., 1998; Smith *et al*., 1998).

In our study we used bupivacaine (heavy) as spinal anaesthetic agent; no opioid was added as adjuvent as it may interfere with the result. Several drugs like meperidine, clonidine, tramodol physostigmine, nefopam etc. was shown to have anti shivering properties so to avoid interference to our study, we avoided use of such drugs intraoperatively (de Witte *et al*., 1997; 2002). Contrary to our study Butwick et al., (2007) in his study showed that intraoperative air-warming during cesarean delivery under spinal anesthesia does not prevent maternal hypothermia, this controversy in study may be because of difference in prewarming duration though it is not clear since we didn't have a control group. Horn *et al*., (2002) studied active warming during cesarean delivery in the perioperative period after epidural anasthesia reduced hypothermia and improved neonatal outcome. Our measures for neonatal outcomes (Apgar score) persisted within normal limit, however the impact on foetal well-being of maternal hypothermia remain uncertain. Laburn *et al*., (2002) in his study on pregnant women showed that varies thermoregulatory strategies appear to protect fetus from changes in its thermal environment.

Limitations

There are few limitations to our study. We did not compare both warming group with a control group, as it was not ethical to expose the patients to perioperative hypothermia. Patients waiting time in pre operative room increased because of the prewarming which was uncomfortable for some patients.

5. CONCLUSION

It is important to prevent hypothermia and shivering in patients undergoing surgery not only under general anaesthesia but also spinal anaesthesia. Warming the patient preoperatively has shown reduction in rate of fall in core temperature compared to warming the patient only intraoperatively. But there was no significant difference between the two groups. Both the technique is effective in reducing hypothermia and shivering to some extent.

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Author contributions

Study conception: Dr.Aruna Chandak and Dr.Vijay Chandak, Study design: Dr.Vivek Chakole, Data collection, analysis and interpretation of results: Dr.Krishnendu S and Dr.Aruna Chandak, Manuscript Preparation: Dr.Krishnendu S.
All authors reviewed the results and approved final version of the manuscript.

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Conflict of interest

There are no conflicts of interests.

Informed consent

Written and oral informed consent was obtained from all individual participants included in the study.

Ethical approval for the study

The study was approved by Institutional Ethics Committee in its meeting held on 13/12/20019 in Jawaharlal Nehru Medical College and Acharya Vinoba Bhave Rural Hospital (Meghe), Wardha. Datta Meghe Institute of Medical Sciences (Deemed to be university) Ethical committee clearance code: DMIMS (DU) /IEC/dec-2019/8580.

Data and materials availability

All data associated with this study are present in the paper.

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