PROSPECTIVE COHORT STUDY OF EFFECT OF PREOPERATIVE WARMING USING WARMED IV FLUIDS AND AIR WARMERS ON SHIVERING AND HYPOTHERMIA DURING CAESAREAN SECTION UNDER SPINAL ANAESTHESIA

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ABSTRACT

BACKGROUND
The caesarean section under spinal anaesthesia is a common procedure performed in operation theatres. Perioperative shivering and hypothermia will be present in the majority of these cases. Shivering is bothersome to mother and the anaesthesiologist and will impair early maternal bonding to the baby. The maintenance of normothermia is an important function of the autonomic nervous system. Autonomic blockade at spinal level leads to internal redistribution of heat from the core to peripheral compartment and a rapid decline in core temperature. It is often challenging to treat core-peripheral redistribution of heat. However, redistribution can be prevented by preanaesthetic cutaneous warming. The purpose of this study is to compare the efficiency of forced air pre-warming and pre-warmed intravenous fluids 15 minutes prior to spinal anaesthesia in patients undergoing a caesarean section.

MATERIALS AND METHODS
This is a prospective cohort study conducted in 72 term mothers of ASA class I and II in the age range between twenty and thirty years, scheduled for caesarean section under spinal anaesthesia in our institute during a period of 6 months. 24 patients who received forced external air warmers were designated as group E and 24 patients who received warmed intravenous fluids as a method of prewarming were designated as group F. The remaining 24 patients received neither of these and were designated as group C. Intraoperative blood pressure, heart rate, level of sensory blockade, presence of nausea, vomiting, fluids given, and blood loss were monitored. Core temperature was measured using an infrared thermometer (GT- 302A) every 15 minutes after spinal anaesthesia. Skin temperature was measured using a Skin Temperature Probe® (NIHON KOHDEN) every 15 minutes after spinal anaesthesia. The intensity of shivering was graded using a scale from 0 to 3.

RESULTS
The mean skin and core temperature measurements immediately after spinal anaesthesia to the last measurement at 1 hour of forced air warming group E & warm intravenous fluid group F was found to be higher than control group C. It was statistically significant (p-value > 0.05). The mean skin temperatures and core temperatures observed immediately after spinal anaesthesia for group E, group C and group F were 34.838±.1610^{0}C/35.692±.1613^{0}C, 34.633±.2615^{0}C/35.446±.2702^{0}C and 34.788±.2437^{0}C/35.617±.2777^{0}C respectively. There was no statistically significant difference in mean and core temperatures between group E & F. Incidence of clinically appreciable shivering (grade 2& 3) in group E is 8/24(33.3%), Group C is 22/24(91.6%), and Group F is 12/24(50%).

CONCLUSION
Prewarming with forced air warmer and warm intravenous fluids markedly increases peripheral heat content causing the decreased core to periphery temperature gradient. Active warming measures are effective in preventing hypothermia when they are applied preoperatively.

KEYWORDS
Core to Periphery Temperature Gradient, Prewarming, Core Temperature, Skin Temperature.

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BACKGROUND

The maintenance of normothermia is an important function of the autonomic nervous system in man. Cellular and tissue dysfunction sets in at even minor deviations from normal core body temperature. Normal core temperature is maintained within a narrow range of 37.5-38.5^{0}C. It is maintained mainly by behavioural and physiological mechanisms. Up to 56.7%[22] of patients undergoing spinal anaesthesia will have shivering. Perioperative shivering occurs in 85% of patients undergoing caesarean section under spinal anaesthesia.[1] Caesarean sections are the commonest procedure done under spinal anaesthesia. Shivering increases postoperative pain by stretching surgical incisions and interferes with monitoring techniques (pulse oximetry, NIBP). Shivering causes increase in intraocular and intracranial pressures, causing disturbance to mothers during labor and delivery.[2] Shivering increases oxygen consumption and can aggravate hypoxemia.[3]

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Regional anaesthesia is associated with hypothermia and shivering. Spinal anaesthesia causes internal redistribution of heat from the core to the peripheral compartment.[4] There is a loss of thermoregulatory vasoconstriction below the level of the spinal block. Thermoregulation is altered during spinal anaesthesia causing a 0.5^{0}C decrease in vasoconstriction and shivering thresholds.[5] All these above-mentioned factors will aggravate hypothermia of patients undergoing caesarean section under spinal anaesthesia who are already exposed to cold operating room environment.

Redistribution of heat can be prevented by cutaneous warming before anaesthesia. Prewarming will increase peripheral tissue heat content and decreases the core-to-peripheral tissue temperature gradient.[6] As the gradient decrease, there is less redistribution from core leading to lesser fall in core temperature.

One promising approach in reducing hypothermia during anaesthesia is the application of external forced air warmers. It will increase heat content of the periphery. Administration of warmed intravenous fluids will do the same. But all these active warming measures are found to be effective in preventing hypothermia when applied preoperatively.[7] In the setting of this existing background, the present study has been conducted to find the effect of preoperative warming using warmed intravenous fluids and air warmers on shivering and hypothermia during caesarean section under spinal anaesthesia.

MATERIALS AND METHODS

The Institutional Research Committee and Ethics Committee clearance was obtained prior to the study. This prospective cohort study included patients in 38th to 40th week of pregnancy who underwent elective caesarean section in Amala Medical College, Thrissur, during a period of six months. Patients between the age of 20 and 30 years, belonging to ASA class I & II with a gestational age of 38-40 weeks were selected.

Patients with gestational hypertension, twin pregnancy, placenta previa, weight <50kg and >100kg and failed spinal or inadequate spinal anaesthesia were excluded from the study.

A sample size of 24 patients in three groups was calculated using statistical methods with respect to a previous study by Sung Hee Chung et al.[8]

The core temperature was measured using an infrared thermometer (GT- 302A) every 15 minutes after spinal anaesthesia. The skin temperature was measured using a Skin Temperature Probe® (Nihon Kohden) every 15 minutes after spinal anaesthesia. Grading of shivering was done using an existing scale were 0 means no shivering, 1 denotes one or more of the following: Piloerection, peripheral vasoconstriction or peripheral cyanosis without visible muscular activity, 2 is a visible muscular activity confined to one group of muscle and 3 denotes gross muscular activity involving the whole body. The incidence of clinically appreciable shivering equals the number of patients having grade 2 & 3 shivering divided by total number of patients in that group* 100.

Figure: 1 Forced External Air Warmer

Figure: 2 Fluid Warmer

The study protocol was explained to the patients and written informed consent was obtained from all the participants. Prewarming techniques were applied in the preanaesthetic room maintained at room temperature. Patients were observed in three groups. Forced external air warmer group (group E) received an application of Bair hugger air warmers from toes to neck in supine position.

The temperature of warmer set at 38^{0}C and applied for 15 minutes. Fluid warmer group (group F) received a 10 ml/kg/hour intravenous fluid of Ringer lactate using a fluid warmer set at 40⁰C during a period of 15 minutes before spinal anaesthesia. The control group (group C) received neither of these prewarming measures. Core temperature (tympanic membrane) and skin temperature of the arm were measured, and degree of shivering was graded simultaneously.

The temperature at operation theatre was set at 20⁰C. The core and skin temperatures were measured at the time of arrival of the patient. Spinal anaesthesia was performed under strict asepsis in right lateral position at $L_4 - L_5$ intervertebral space using 25 Gauge Quincke/Whitacre needle with 0.5% hyperbaric bupivacaine 2.2cc. Level of the block was checked. Core and skin temperatures were measured after spinal anaesthesia and every 15 minutes thereafter up to 1 hour. The degree of shivering, fluid is given and other events like vomiting, nausea, and blood loss were recorded. Temperatures were recorded to an average value of three measurements for accuracy. The same thermometer (with disposable sleeves) was used for all patients and readings were taken by the same operator. Skin temperatures of upper arm were measured. Data were coded and entered into Microsoft Excel for Windows and analyzed using the SPSS software Version–16. Continuous data were expressed as means (SDs); categorical data were expressed as numbers of occurrences (percentage). Shivering grades of 2 and 3 were considered as clinically appreciable shivering. Two-sided Student's t-test was employed for continuous variables and chi-square for non-continuous variables. Results were considered statistically significant if $P < 0.05$.

RESULTS

Patients were well matched with regards to age, weight and height ($p>0.05$).

	Groups			P value
	E	C	F	
Age	25.54 ± 2.570	25.88 ± 2.610	25.38 ± 2.901	0.808
Height	157.50 ± 4.075	156.58 ± 4.960	158.38 ± 4.924	0.418
Weight	71.42 ± 7.034	71.50 ± 6.859	70.33 ± 7.750	0.823

Table 1 Demographic Data

Fasting hours, room temperature, operating room temperature, the volume of fluids given, and estimated blood loss were taken into consideration. Values were represented as mean ± SD. There were no statistically significant differences among the three groups ($p>0.05$).

The mean core temperature measured immediately after the spinal anaesthesia for group E, F and C were 35.692 ± 0.1613⁰C, 35.617 ± 0.2777⁰C and 35.446 ± 0.2702⁰C respectively. There was a statistically significant difference of mean core temperature of control group when compared with group E & F. ($p<0.05$).

This significant difference was found in every measurement thereafter till 1 hour. Between groups E and F there was no statistically significant difference in mean core temperature.

Time (minutes)	Core Temperature(⁰C)			P value
	E	C	F	
0	35.692 ± 0.1613	35.446 ± 0.2702	35.617 ± 0.2777	0.003
15	35.492 ± 0.2244	35.275 ± 0.2642	35.512 ± 0.2659	0.003
30	35.404 ± 0.2349	35.175 ± 0.3554	35.404 ± 0.2805	0.011
45	35.342 ± 0.2636	35.154 ± 0.3599	35.375 ± 0.2251	0.021
60	35.321 ± 0.2734	35.167 ± 0.3266	35.308 ± 0.3189	0.033

Table 2. Core Temperature Variation

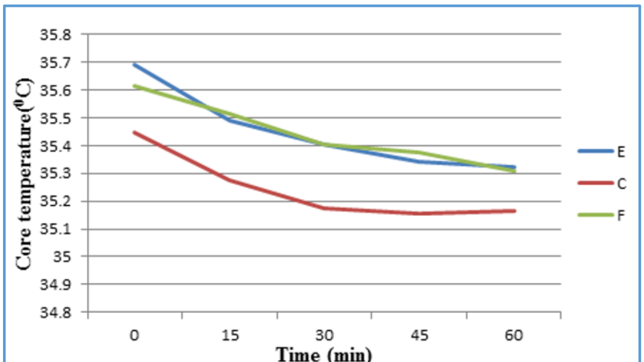

Figure: 3. Core Temperature Variation

The mean skin temperature measured immediately after the spinal anaesthesia for group E, F and C were 34.838 ± 0.1610⁰C 34.788 ± 0.2437⁰C and 34.633 ± 0.2615⁰C respectively. There was a statistically significant difference in mean skin temperature of control group when compared with group E &F. ($p<0.05$). This significant difference was found in every measurement thereafter till 1 hour. Between groups E and F there was no statistically significant difference in mean skin temperature.

Time (min)	Skin Temperature(⁰C)			P value
	E	C	F	
0	34.838 ± 0.1610	34.633 ± 0.2615	34.788 ± 0.2437	0.007
15	34.754 ± 0.1911	34.483 ± 0.2548	34.663 ± 0.2667	0.001
30	34.613 ± 0.2419	34.346 ± 0.1956	34.600 ± 0.2284	0.0001
45	34.567 ± 0.2180	34.300 ± 0.2043	34.554 ± 0.2859	0.0001
60	34.521 ± 0.2449	34.279 ± 0.1865	34.475 ± 0.2192	0.001

Table 3. Skin Temperature Variation

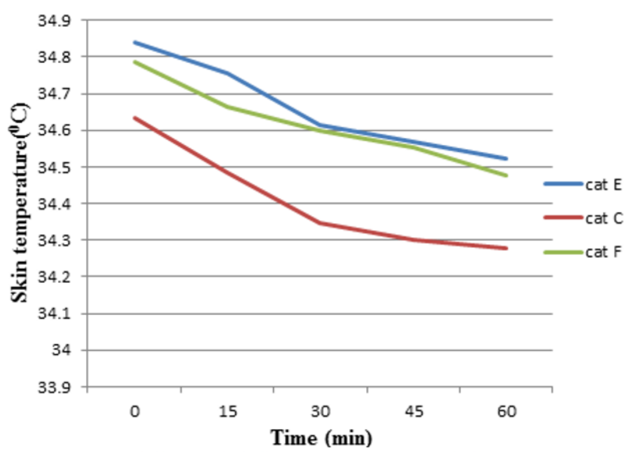

Figure: 4. Skin temperature variation

There were statistically significant changes in the intensity of shivering in Group E, Group C, and Group F. The incidence of shivering in all the three groups were measured considering clinically appreciable shivering grades being grade 2 and 3. Incidence in Group E is 8/24(33.3%), Group C is 22/24(91.6%) and Group F is 12/24(50%).

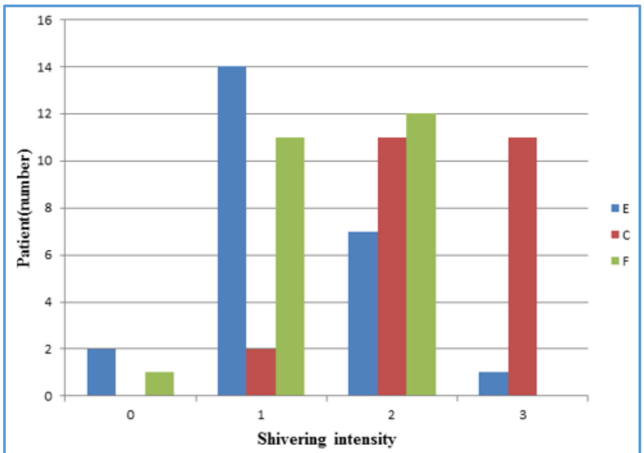

Figure: 5. Intensity of Shivering

There was no statistically significant difference among three groups (p >0.05) in ASA status, the incidence of nausea and vomiting and level of sensory blockade.

DISCUSSION

Maintenance of normothermia and avoidance of shivering and other complications of hypothermia are some of the key responsibilities of the anaesthesiologist. Exposure to the cold environment will induce behavioural and physiological alterations that will prevent heat loss in order to maintain core temperature in its normal range and if the needed body will generate heat by shivering and non-shivering thermogenesis. Anaesthesia abolishes these protective mechanisms. Neuraxial anaesthesia prevents vasoconstriction and shivering in blocked regions. The present study discusses the effect of prewarming in preventing hypothermia and shivering in patients undergoing caesarean section under spinal anaesthesia.

The mean skin temperatures after spinal anaesthesia of Group E, Group C and Group F were 34.838 ± 0.1610^{0}C, 34.633 ± 0.2615^{0}C and 34.788 ± 0.2437^{0}C respectively. Group E and F were significantly warmer compared to the control group and results were statistically significant (p<0.05). This significant difference was found in every 15 minutes of temperature measurement until 1 hour. In other words, fall in core temperature was less in group F &E when compared with group C. In the present study, after spinal anaesthesia core temperature showed a decreasing trend in all the three groups. The pattern of fall in temperature was almost similar in all the three groups. The most contributing cause of hypothermia in neuraxial anaesthesia is redistribution. Redistribution continued to play even up to 60 minutes after spinal anaesthesia. Redistribution during neuraxial anaesthesia causes temperature fall initially up to 89% and is mainly restricted to the leg.[9]

Prewarming by either forced external air warmer or fluid warmer markedly increases peripheral heat content. These active warming measures are not supposed to affect core temperature. As heat energy shifts from a higher concentration (core) to a lower concentration (skin) core temperature falls. In a study by Horn EP et al[10] 30 patients undergoing elective caesarean delivery were randomly assigned to forced-air warming or to passive insulation. Warming initiated 15 minutes before the induction of epidural anaesthesia. Core temperature measured from tympanic membrane and shivering was graded by visual inspection. Core temperatures after 2 hours of anaesthesia were more in the actively warmed (37.1 ^{0}C +/- 0.4^0 C) than in not warmed (36.0 ^{0}C +/- 0.5 ^{0}C; P < 0.01) patients. These findings are consistent with our study and the prewarming time of 15 minutes was similar in both studies.

Sung Hee Chung et al[8] did a randomized control trial evaluating the degree of hypothermia and shivering in 45 patients undergoing caesarean section under spinal anaesthesia. They evaluated skin temperature after spinal anaesthesia and every 15 minutes after spinal anaesthesia in three groups. Skin temperature at the arm in 15th and 30th minute were found to be higher in forced external air warming group and fluid warming group while comparing with the control group (not prewarmed). The gradual increment of temperature after spinal anaesthesia in 15th and 30th minute was statistically significant, but these findings were not consistent with our study. In our study skin temperature showed a gradually decreasing trend from the onset of spinal anaesthesia.

The incidence of clinically appreciable shivering (grade 2& 3) in group E was 8/24(33.3%) and Group F was 12/24(50%) in our study. In the control group, it was 22/24(91.6%). In a study done by Nicholas Workhoven[11] on the effect of warmed intravenous fluids on shivering in parturient, the group exposed to room temperature had intense shivering during the intraoperative period, usually lasting much longer than 5 minutes 14/22 (64%). In warmed fluid group only 3/22 (14%) of the parturient had to shiver and was found to be less intense and of short duration. This was a statistically significant difference (P < 0.005). A study done by Sung Hee Chung et al[8] was a randomized control trial evaluating the degree of hypothermia and shivering in

45 patients undergoing caesarean section under spinal anaesthesia. The incidence of shivering was significantly less in forced external air warmer and fluid warmer group than control group. Results were consistent with the present study.

Limitations

The limitations of our study were that the observer was not blinded and hence might have resulted in bias. The study could have been extrapolated to involve other abdominal surgeries to reinforce the results. Intermittent vasopressor boluses during periods of transient hypotension after spinal anaesthesia might have affected the temperature regulation and resulted in bias. The grade 3 shivering patients received tramadol or pethidine intraoperatively and that might have resulted in a decreased duration of shivering.

CONCLUSION

From this study, it is reasonable to conclude that redistribution of body heat is the major initial cause of hypothermia in patients with neuraxial anaesthesia. Prewarming markedly increases peripheral heat content causing the decreased core to periphery temperature gradient. Active warming measures are effective in preventing hypothermia only when they are applied preoperatively. Both warmed I.V. fluids and forced external air warmers are equally effective in preventing hypothermia and shivering.

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