Original Research Article

Effect of intravenous fluid and local anaesthetic warming on core temperature following subarachnoid block for Caesarean section

Abstract

Background:

Hypothermia and shivering often complicate spinal anaesthesia for Caesarean section, and has necessitated the search for an effective and affordable warming method for parturient.

AIM

To compare the effects of intravenous fluid and local anaesthetic warming on core temperature during Caesarean section under spinal anaesthesia.

METHOD:

One hundred and sixteen consenting parturients aged 18 to 40 years with ASA physical status class II scheduled for elective Caesarean section were recruited into the study. Patients were randomly allocated into groups I, II, III and IV. All the patients were preloaded with 15 ml/kg of normal saline over 15 minutes before institution of subarachnoid block in the sitting position. Warm intravenous fluid and warm intrathecal bupivacaine, warm intravenous fluid and intrathecal bupivacaine at room temperature, intravenous fluid at room temperature and warm intrathecal bupivacaine, and both intravenous fluid and intrathecal bupivacaine at room temperature were administered to patients in groups I, II, III, IV respectively. Data collected included core temperature (tympanic membrane) using a thermoscan, shivering using the 5-point scale of Wrench. Neonatal rectal temperature was measured and adverse effects observed on the parturients recorded. Monitoring of core temperature was continued in the post anaesthesia care unit until full recovery and discharge.

RESULT:

All the 116 patients completed the study. While core temperature change was highest (-0.43 ± 0.30) in group IV and lowest in group I (-0.07 ± 0.58), it was -0.16 ± 0.09 in group II and -0.24 ± 0.16 in group III, p=0.001. Hypothermia was observed in group IV, with an incidence of 10.3%. Group IV also had the highest incidence of shivering (31%), followed by group III (10.3%) and

group II (6.9%) while group I had zero incidence of shivering. The neonatal temperature was similar across the study groups. Vomiting was recorded in one patient in groups III (3.4%) and IV (3.4%). Bradycardia occurred in two patients in groups III (6.9%) and one patient in group IV (3.4%). Hypotension was observed in two patients in group III (6.9%) and one patient in group IV (3.4%).

CONCLUSION:

Warming of intravenous fluid and intrathecal bupivacaine reduced maternal temperature change during Caesarean section under subarachnoid block, but there was no significant difference in the incidence of shivering between the combination of warm intravenous fluid and warm intrathecal bupivacaine, and warm intravenous fluid alone.

Keywords: *Warm intravenous fluid, warm bupivacaine, Caesarean section, spinal anaesthesia, shivering, core temperature*

INTRODUCTION

Regional anaesthesia is the preferred option for Caesarean section (CS),[1] and single shot spinal anaesthesia is more commonly used because of faster onset, and superior quality of block that is cost effective.[2] Hypothermia commonly complicates spinal anaesthesia[3] leading to perioperative shivering which can occur in up to 85% of patients undergoing Caesarean delivery.[4]

Hypothermia under spinal anaesthesia may be due to internal redistribution of heat from the core to the peripheral compartment,[5] and loss of thermoregulatory vasoconstriction below the level of the spinal block.[6, 7] Core temperatures 1-2 ^{O}C below normal have been associated with adverse outcomes, such as shivering which aggravates postoperative pain, interferes with patient monitoring and increases oxygen consumption. Shivering also increases the incidence of surgical wound infection, prolonged hospitalization, morbid cardiac events, increased blood loss and allogeneic transfusion requirements.[8]

The prevention of redistribution of body heat from the core to periphery may prove difficult, but it could be achieved by preanaesthetic cutaneous warming. However, studies of various interventions toward reducing the occurrence of hypothermia have produced different results.[9,10,11] Limited studies have compared the effectiveness of intravenous fluid and local anaesthetic warming on the maintenance of core temperature. Therefore, the aim of this study was to compare the effectiveness of warmed intravenous fluid and warmed local anaesthetic on the maintenance of maternal core temperature during Caesarean section under spinal anaesthesia.

MATERIALS AND METHODS

This prospective comparative randomized study involved 116 consenting parturients with American Society of Anaesthesiologists physical status class I or II scheduled for elective Caesarean section under spinal anaesthesia after approval from the University of Port Harcourt Teaching Hospital's Ethics Committee (Ref. No. **UPTH/ADM/90/S.II/VOL.X/732/2019)**. Exclusion criteria were parturient who refused to participate, maternal fever, pregnancy-induced hypertension, obesity (body mass index > 35 kg.m-^{2}), hypersensitivity to amide local anesthetics and failure of spinal anaesthesia requiring conversion to general anaesthesia.

Pre-anaesthetic assessment was carried out on all the parturients in preanaethesia clinic 48 hours before day of surgery in order to establish parturients' fitness and eligibility for inclusion in the study. Request was made for two units of blood to be grouped and cross-matched for the procedure.

Biggler Medizin Elecktronik BW 585M™ fluid warmer was used to warm intravenous fluid to 37 ^{O}C. Warm hyperbaric bupivacaine was obtained by storing the hyperbaric bupivacaine in a Lauda™ laboratory water bath at 37 ^{O}C for an hour before surgery. The room temperature was set at 26 ^{O}C, where the IV fluids and hyperbaric bupivacaine were stored at least one hour before surgery for the groups which warming was not required.

Parturients were randomly assigned to one of four groups of 29 each (I, II, III or IV) by a computer-generated random number table (www.psychicscience.org/random.aspx). While group I received warm intravenous fluids and hyperbaric bupivacaine at 37 ^{o}C, group II had warm intravenous fluids at 37 ^{o}C and hyperbaric bupivacaine at room temperature (26 ^{o}C). Parturients in group III received intravenous fluids at room m temperature and warm hyperbaric bupivacaine (at 37 ^{o}C) and group IV had intravenous fluids and hyperbaric bupivacaine both at room temperatures (at 26 ^{o}C). A selected nurse who was not involved in the study opened the group assignment envelope and prepared the syringe. An Anesthesiologist performed the anaesthesia and also collected the data The baseline vital signs (SPO_2, PR, NIBP, ECG and core temperature) were taken, and venous access was established on the non-dominant hand with a 16 G intravenous cannula. All the patients were pre-loaded with 15 ml/kg of 0.9% saline infusion over 10-15 minutes, the temperature dependent on the group allocation. While in the sitting position, sub-arachnoid block (SAB) was carried out under aseptic condition with 10 mg (2 ml) hyperbaric bupivacaine, at L_4/L_5 inter-vertebral space using 25 G Quincke needle.

The patient was then returned to the supine position with lateral displacement of the gravid uterus after institution of the spinal anaesthesia by the researcher, and intervention appropriate for each group was applied.

Sensory block was assessed using temperature discrimination technique with cotton wool soaked in alcohol. The maximum sensory block height and the time to intravenous reach maximum sensory block height (duration in minutes) were noted. Motor block was assessed using Bromage scale[12] (score 0: no block; score 1: ability to flex knees but not the hips; score 2: unable to flex knees, ankle movement present; score 3: no movement possible in any lower extremity) and time

to achieve Bromage score 3 was recorded. Core temperature (tympanic membrane) was measured and recorded preoperatively and every 1 min for the first 5 min followed by every 10 min till the end of surgery using the Braun ThermoScan® 3(IRT 3020). The operating room temperature was also recorded at this time with a clinical thermometer hung on the operating room wall.

Pulse rate (PR), non-invasive blood pressure (NIBP), and peripheral arterial oxygen saturation (SPO_2) were monitored every 2 minutes for 10 minutes, and thereafter every 5 minutes till the end of surgery. Temperature was monitored every 5 minutes. Outcome measures were documented by the research assistant, a senior registrar in anaesthesia who was blinded to the intervention the patient received.

After completion of surgery, the patient was transferred to the recovery room where core temperature was noted on arrival, at 15 min and 30 min. Occurrence of shivering was noted, and classified using the 5 -point scale of Wrench[13] which comprised grades: 0 = no shivering, 1 = one or more of the following: piloerection, peripheral vasoconstriction, peripheral cyanosis without other cause, but without visible muscular activity, 2 = visible muscular activity confined to one muscle group; 3 = visible muscular activity in more than one muscle group, 4 = shivering of the whole body. Shivering was treated with tramadol 25 mg intravenously.

A Pediatrician assessed the Apgar scores of the newborn at 1 and 5 minutes, and also collected blood samples from double clamped umbilical vessels immediately after delivery for determination of arterial blood gases. Neonatal rectal temperature was noted with a clinical thermometer.

Duration of surgery was defined as the time from when skin incision was made to last stitch on the skin. Perioperative blood loss was estimated by gravimetric method. Desaturation below 94% was managed with 100% oxygen delivered through the Bain's circuit at a flow rate of 6 litres per minute. Hypotension was defined as a fall in mean arterial pressure to less than 65 mmHg and was treated with rapid infusion of 250 ml of 0.9% normal saline (according to group allocation of temperature of fluid), and bolus injection of 5mg ephedrine, which was repeated as indicated. Bradycardia (heart rate <50) was treated with IV atropine 0.5 mg. Five international units of

intravenous oxytocin was administered slowly at the delivery of the baby followed by 10 IU in 500 ml of normal saline at the rate of 30 drops per minute.

Complications that occurred (nausea, vomiting, bradycardia, hypotension, shivering, dizziness/sleepiness, respiratory depression, post dural puncture headache) were recorded and treated. The parturients were transferred from the recovery room when the modified Aldrette's score was 9 or more (Able to flex her foot and had proprioception in the great toe). The time of discharge was also noted.

Sample size determination

The sample size was calculated using the formula for comparison of means.[14]

$$n = \frac{(U+V)^2 X \ (SD1^2 + SD2^2)}{(u_1 - u_2)^2}$$

This is useful for unpaired sample i.e., two different groups with continuous variables e.g., temperature.

Where,

n = minimum sample size

V = desired level of statistical significance, set at 95% equivalent to 1.96.

U = desired power of 90%, equivalent to 1.28.

SD1= standard deviation of maternal core body temperature among

control group. The mean change ± standard deviation = -2.184 ± 0.413

SD2= standard deviation of maternal core body temperature among

treatment group. The mean change ± standard deviation = -1.934 ± 0.439

The result of a similar study by Goyal et al[9] was used. The mean change in the core body temperature at the end of anaesthesia was used.

Substituting

SD1 = 0.413

SD2 = 0.439

$\mu 1 - \mu 2 = 0.38$ (expected difference)

Therefore $n = \frac{(1.28 + 1.96)^2 \times (0.413^2 + 0.439^2)}{0.38^2}$

$n = \frac{(10.4976) \times (0.170569 + 0.192721}{(0.38)^2}$

$$n = \frac{10.4976 \times 0.36329}{0.1444}$$

$$n = \frac{3.8136731}{0.1444}$$

N = 26.4

Therefore, sample size = 26.

Sample size was increased by 10% to provide for attrition i.e., 26 + 2.6 = 28.6 = 29 parturient. For the 4 groups, there will be 116 participants in the study.

Statistical Analysis

Data generated from this study were analyzed using IBM (® SPSS® statistics software version 20 (Armonk, New York). The data was collected and presented in tabular and chart forms as appropriate. Quantitative variables were summarized using means and standard deviations while qualitative variables were expressed as proportions and frequencies. Differences in means were compared using statistical test of one-way ANOVA tables while differences in proportions were compared using Chi square and Fisher exact as appropriate. A *p*-value of < 0.05 was considered statistically significant.

RESULTS:

Demographic profile (age, body mass index and gestational age) of all patients in both groups I to IV was statistically comparable [Table I].

Table I: Comparison of maternal demographics across study groups

Variables	**Group I** **Mean ± SD**	**Group II** **Mean ± SD**	**Group III** **Mean ± SD**	**Group IV** **Mean ± SD**	**ANOVA**	***p*-value**
Age in years	29.93±3.24	31.62±4.10	30.52±2.36	30.52±2.88	1.403	0.246
BMI (kg/m^2)	35.74±2.67	35.94±2.49	33.85±3.77	35.54±3.53	2.660	0.052
Gestational age in weeks	37.41±0.62	37.52±0.51	37.41±0.68	37.38±0.56	0.289	0.834

SD - Standard deviation BMI - Body Mass Index

Table II shows that the mean maternal core temperature at the end of surgery were 37.11± 0.25 ^{O}C, 36.97±0.23 ^{O}C, 36.89±0.28 ^{O}C and 36.62±0.33 ^{O}C for groups I, II, III and IV

respectively. Group I had the highest core temperature while the lowest core temperature was observed in group IV. The difference in the mean maternal core temperature at the end of surgery across the groups was statistically significant. (p=0.0001). Inter group analysis (post-Hoc) revealed that there was no significant difference between the final core temperature in groups II and III, p=0.799. There was significant difference between group IV and groups I, II and III.

The change in mean maternal core temperature at the end of surgery were –0.07±0.58 ^{O}C, -0.16±0.09 ^{O}C, -0.24±0.16 ^{O}C and -0.43±0.30 ^{O}C for groups I, II, III and IV respectively p=0.0001. The change in mean maternal core temperature across the groups were statistically significant. (p=0.001), (Table II). Further analysis revealed that there was no significant difference in the mean core temperature between group II and III (p=0.899). Intergroup analysis between groups I and III was statistically significant (p=0.029).

Table II: Comparison of Baseline, end of surgery, change in temperature and duration of surgery among groups in the study

	Group in study					
Temperature (^{O}C) Time (min)	**Group I Mean ± SD**	**Group II Mean ± SD**	**Group III Mean ± SD**	**Group IV Mean ± SD**	**ANOVA**	***p*-value**
Baseline		37.12 ±0.22	37.13±0.27	37.0±0.16	0.744	0.528
Temperature at end of surgery	37.11±0.25	36.97 ±0.23	36.89±0.28	36.62±0.33	16.414	0.0001*
Change in temperature**	-0.07±0.58	-0.16±0.09	-0.24±0.16	-0.43±0.30	6.034	0.001*
Duration of surgery	45.55±10.	52.69±12.	56.93±9.4	48.07±10.0	6.280	0.001*

*Statistically significant; SD – Standard Deviation; ANOVA – Analysis of Variance
**Difference in temperature between baseline and end of surgery (Baseline – temperature at end)

A total of 14 (12.06%) parturients shivered during the study. Group IV had the highest incidence of shivering (31%), followed by group III (10.3%) and group II (6.9%) while no shivering was observed in group I. Although there was significant difference in the incidence of shivering across the study groups (p=0.003) (Table III); intergroup analysis showed that there was

significant difference between groups I and IV (p=0.001) and between groups II and IV, (p=0.04). There was no statistically significant difference when other groups were compared.

Table III: Incidence of shivering among study groups

	Shivering		
Study groups	**Yes n (%)**	**No n (%)**	**Total n (%)**
Group I	0 (0.0)	29 (100.0)	29 (100.0)
Group II	2 (6.9)	27 (93.1)	29 (100.0)
Group III	3 (10.3)	26 (89.7)	29 (100.0)
Group IV	9 (31.0)	20 (69.0)	29 (100.0)

*Fisher's exact test = 12.926; p-value = 0.003** *statistically significant

Inter-group analysis

Study groups	**Shivering**		**Total n (%)**	***Fisher's exact test***
	Yes n (%)	**No n (%)**		
Group I & IV				
Group I	0 (0.0)	29 (100.0)	29 (100.0)	*0.001* *
Group IV	9 (31.0)	20 (69.0)	29 (100.0)	
Group II & IV				
Group II	2 (6.9)	27 (93.1)	29 (100.0)	*0.04* *
Group IV	9 (31.0)	20 (69.0)	29 (100.0)	

* Statistically significant p<0.05

More patients in Group IV had Grade 3 shivering was observed in 6 patients in group IV, and 1 each in Groups II and Group III. Three patients in Group IV had grade 2 shivering when compared to 2 in Group III and 1 in Group II. However, these differences were not statistically significant as shown on Table IV.

Table IV: Severity of shivering among study groups

Study groups	Shivering				Total n (%)
	Group I n (%)	Group II n (%)	Group III n (%)	Group IV n (%)	
Grade 0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Group 1	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Grade 2	0 (0.0)	1 (100.0)	2 (66.7)	3 (33.3)	6 (42.9)
Grade 3	0 (0.0)	1 (100.0)	1 (33.3)	6 (66.7)	8 (57.1)
Total	**0 (0.0)**	**2 (100.0)**	**3 (100.0)**	**9 (100.0)**	**14 (100.0)**

Fisher's exact test = 1.069; p-value = 0.586

Table V showed that the median APGAR scores at 1st and 5th minute were comparable across the study groups. APGAR score for the 1st minute was 8 for groups (I-IV) and 9 for groups (I-IV) at the 5^{th} minute. The APGAR scores at the 5^{th} minute were higher but their differences were not statistically significant as shown by the *p*-values of 4.887 and 0.180 respectively.

Table V: Comparison of the APGAR scores of neonates born to mothers of the study groups

Variables	Group I Median (Range)	Group II Median (Range)	Group III Median (Range)	Group IV Median (Range)	Kruskal-Wallis test	*p*-value
1 minute APGAR score	8 (6 – 9)	8 (5 – 9)	8 (6 – 9)	8 (6 – 9)	1.625	4.887
5 minutes APGAR score	9 (8 – 10)	9 (9 – 10)	9 (9 – 10)	9 (9 – 10)	0.654	0.180

S.D – Standard deviation

Score 8-10: normal, score 6-7: mild birth asphyxia, Score 4-5: moderate birth asphyxia
Score 0-3: severe birth asphyxia

There was no abnormality in the mean biochemical findings of the neonates in any of the groups. The p-values for the PO_2, pH, HCO_3, PCO_2 and Base Excess were 0.634, 1.000, 1.000, 1.000 and 1.000 respectively as shown in Table VI.

Table VI: Comparison of the mean biochemical findings of the neonates in the study groups

Variables	Group I Mean ± SD	Group II Mean ± SD	Group III Mean ± SD	Group IV Mean ± SD	ANOVA	*p*-value
PO_2	98.69±1.07	98.59±1.09	98.90±0.56	98.86±1.30	0.573	0.634
pH	7.41±0.00	7.40±0.00	7.39±0.00	7.42±0.00	0.000	1.000
HCO_3	22.00±0.00	23.00±0.00	21.00±0.00	22.00±0.00	0.000	1.000
PCO_2	42.00±0.00	41.00±0.00	40.00±0.00	41.00±0.00	0.000	1.000
BE	2.01±0.00	2.00±0.00	2.02±0.00	2.01±0.00	0.000	1.000

SD – Standard deviation

Solutions with a pH less than 7.35 are acidotic and solutions with a pH greater than 7.45 are alkalotic. There was no significant difference in the heart rate, mean arterial pressure, oxygen saturation and neonatal temperature between the four groups. The neonatal rectal temperature was also comparable across the study groups. Vomiting was observed in 1 (3.4%) patient in groups III. Bradycardia occurred in two patients in groups III (6.9%) and one patient in group IV (3.4%). Hypotension was observed in two patients in group III (6.9%) and one patient in group IV (3.4%).

The line graph in Fig. 1 shows that mean maternal temperature was relatively stable in Group I as depicted by the almost straight line. The change was more pronounced in Group IV while the slope was gentle for Groups II and III.

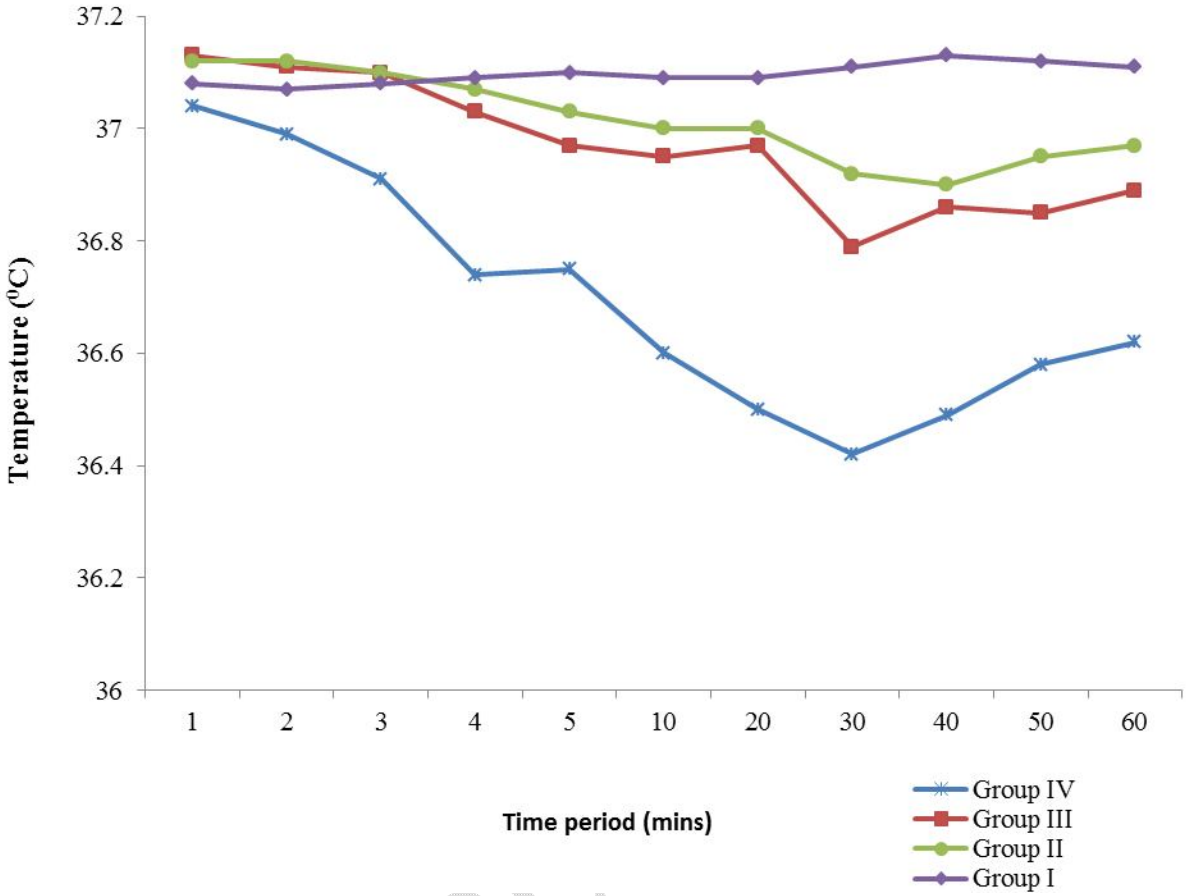

Fig. 1: Showing mean maternal temperature (in ^{o}C) across study groups.

DISCUSSION:

This study showed that the administration of warm intravenous fluid and hyperbaric bupivacaine either alone or in combination minimizes changes in maternal core temperature. However, there was no significant difference when the effects of warm intravenous fluid and warm bupivacaine on maternal core temperature changes were compared. The study also showed the administration of warm fluid alone when compared with the administration of warm intrathecal bupivacaine alone had a lower impact on the core temperature. The differences in the neonatal outcomes in all the groups were not statistically significant.

The findings from this index study corroborated with that of Chung et. al[14] who reported a mean core temperature change of -0.5±0.3 ^{O}C for the warm intravenous fluid group and -0.9±0.4^{O}C for the room temperature fluid group. Another study conducted by Ji-Won et al[15] reported a lower

core temperature change of 0.3±0.3 ^{O}C for the warm intravenous fluid group when compared to 0.5±0.4 ^{O}C for the room temperature group. This observation confirmed higher temperature advantage in patients receiving prewarmed intravenous fluids.

However, De Mattia et al[16] in their study concluded that the use of warmed intravenous infusion on alone during the intraoperative period does not prevent hypothermia. They observed that at the time of exit from the operating room, the median temperature was 34.7 ^{O}C in the control group and 34.3 ^{O}C in the experimental group, with maximum of 35.6 ^{O}C and 36.2 ^{O}C respectively, and p=0.7113. They used digital thermometer for peripheral temperature measurements as opposed to thermoscan for core temperature monitoring in the index study, and this may have been responsible for the difference.

The result of our study showed that core temperature change was lower in those who received warm bupivacaine compared to those who received cold bupivacaine. Mattia et. al[17] also demonstrated that the combination of warm intravenous fluid and warm intrathecal bupivacaine showed superior qualities as regards mean temperature change when compared to warm intravenous fluid or warm intrathecal bupivacaine alone. Studies have confirmed the existence of intrinsically thermo-sensitive neurons in the spinal cord as it has been demonstrated that cooling of the thoracic region of the human body could lead to tachycardia; and cooling the lumbosacral region may lead to bradycardia.[11, 17] Increasing the temperature of the local anaesthetic agent enhances the thermal equalization with the cerebrospinal fluid in a shorter time. Therefore, warming of local anaesthetic agent, e.g., bupivacaine as used and observed in this index study, could reduce the pKa values and increase the non-ionized form of the agent. This could also lead to a reduction of onset time, increased duration of the block, a rapid cephalad spread and lower incidence of shivering as also observed in this present study.[18, 19]

Workhoven et al[20] also studied the effect of warmed versus room temperature intravenous flids on shivering in parturients undergoing anaesthesia for Caesarean sections. Sixty four percent of those given intravenous balanced salt solutions at room temperature shivered, while only 14% in the warm fluid group shivered. Similar result was reported by Chung et. al[14] with shivering incidence of 13.5% in patients who received warmed intravenous fluid and 53.3% in those that received fluid at room temperature. Despite the fact that Chung et al[14] conducted their study in

the temperate region as opposed to tropical setting in our study, shivering was observed in both regions. This supports the theory that shivering is not only attributable to thermoregulatory response to hypothermia but also a physiologic response to temperature changes in the cerebrospinal fluid following the administration of either warm or cold fluids into the subarachnoid space.

However, Woolnough et al[21] could not demonstrate any differences in the incidence of chills in patients receiving warm intravenous fluids via a hotline warmer (28%), from a warming cabinet (36%) and those receiving room temperature fluids (44%). This difference from the findings in our study may be related to the different scales used in assessing the level of shivering. While Woolnough and colleagues used a scale that showed whether the shivering was intermittent or continuous, this index study used a 4-point scale which appears to be more comprehensive in assessing shivering than the 3-point scale. Hypothermia occurring during neuraxial anaesthesia is attributed to multifactorial causes, with redistribution hypothermia being a leading cause. Inclusive is thermoregulation and pharmacology of intrathecal drugs. This may have accounted for the differences in the results of this study and ours.

The index study could not demonstrate any differences in the incidence of shivering between parturients who received warm intrathecal bupivacaine and those who received intrathecal bupivacaine at room temperature. Our finding was similar to that of Kishore et. al[22] who observed a higher incidence of shivering (51.4%) with a decreasing temperature of the injectate. Similarities in the incidences of shivering between parturients who received warm or cold intrathecal bupivacaine in both studies may probably be due to similarity in the sensory block height. Another possible reason for the similarity between this study and ours is the fact that the temperature of local anaesthetic injected into the subarachnoid space rapidly equilibrates with the core temperature of the cerebrospinal fluid.[23]

Contrary to our findings, other studies[11, 24] found higher incidences of shivering in parturients who received bupivacaine at room temperature, when compared to those who received warm intrathecal bupivacaine. Najafianaraki et. al[11] reported 8.3% of shivering in the warm bupivacaine group (bupivacaine stored at 23 ^{O}C) and 39.1% in the cold bupivacaine group (bupivacaine stored at 4 ^{O}C) p=0.002. Najafianaraki et. al[11] added fentanyl to the intrathecal bupivacaine injection, and opioids are known to decrease the incidence of shivering. This may

have contributed to the difference between their study and ours. Similarly, Birzat and colleagues[25] also demonstrated that parturients who received bupivacaine at 37 ^{O}C had lower incidence of shivering (7.5%) compared to those who received bupivacaine at 23 ^{O}C (20%).

The combination of warm intravenous fluid and warm intrathecal bupivacaine showed superior qualities in controlling mean core temperature change and incidence of shivering when compared to warm intravenous fluid or warm intrathecal bupivacaine alone. Mattia et al[17] reported that the combined use of warm intravenous fluids and warm local anesthetics significantly reduced the incidence of shivering. These findings are in agreement with those of the index study where the warm fluid and warm bupivacaine combination group had the lowest incidence of shivering and the difference was statistically significant. Fewer parturients showed symptoms of shivering amongst those who had warm intravenous fluid alone compared to those who received warm hyperbaric bupivacaine although, this difference was not statistically significant. This finding is in contrast to the result of our study in which the number of parturients having shivering was more in the group with warm bupivacaine than those who received warm intravenous fluid alone. The degree of warming produced by warming may be related to both the volume infused and the rate at which the fluid was administered. In our study, the warm fluid was administered as preload and maintenance. One of the warmed fluids given may have diffused into the cerebrospinal fluid hence impacting more influence on the shivering mechanism.

In the index study, no significant difference was observed between the use of warm intravenous fluid and warm intrathecal bupivacaine in terms of mean core temperature change. Also, the difference in incidence of shivering was not significant. However, both interventions independently, effectively minimized the mean core temperature change and incidence of shivering.

Limitations

It was difficult to keep the temperature of bupivacaine exactly at 26 °C and 37 °C, as the small ampoule of hyperbaric bupivacaine would is likely to gain or lose its temperature based on the ambient temperature. Also, the temperature of the hyperbaric bupivacaine could alter the density of the drug and hence affect the maximum level of block obtained and hence possibly alter the

overall result. Finally, the inability to measure the temperature of the cerebrospinal fluid at time of study could likely be another limitation.

CONCLUSION

This study shows that the use of both warm intravenous fluid and warm intrathecal bupivacaine reduced maternal change in temperature during Caesarean section under subarachnoid block.

CONFLICT OF INTEREST

None to declare

REFERENCES

1. Fyneface-Ogan S, Mato CN, Odagme MT. Anaesthesia for Caesarean section: a ten-year review. World Anaesthesia 2005; 8: 18-21.

2. Riley ET1, Cohen SE, Macario A, Desai JB, Ratner EF. Spinal versus epidural anesthesia for Caesarean section: a comparison of time efficiency, costs, charges, and complications. Anesth Analg 1995; 4: 709-12.

3. Frank SM, Beattie C, Christopherson R, Norris EJ, Rock P, Parker S, et al. Epidural versus general anaesthesia, ambient operating room temperature, and patient age as predictors of inadvertent hypothermia. Anesthesiology 1992; 77: 252–57.

4. Girard M, Drolet P. Intrathecal meperidine decreases shivering during Caesarean delivery under spinal anaesthesia. Anesth Analg 2004; 98: 230–34.

5. Matskawa T, Sessler DI, Christensen R, Ozaki M, Schroeder M. Heat flow and distribution during epidural anaesthesia. Anesthesiology 1995; 83: 961–67

6. Ozaki M, Kurz A, Sessler DI, Lenhardt R, Schroeder M, Moayeri A, et al. Thermoregulatory thresholds during epidural and spinal anaesthesia. Anesthesiology 1994; 81: 282-88.

7. Emerick TH, Ozaki M, Sessler DI, Walters K, Schroeder M. Epidural anesthesia increases leg temperature and decreases the shivering threshold. Anesthesiology 1994; 81: 289-98.

8. Schmied H, Kurz A, Sessler DI, Kozek S, Reiter A. Mild intraoperative hypothermia increases blood loss and allogeneic transfusion requirements during total hip arthroplasty. Lancet 1996; 347: 289-92.

9. Goyal P, Kundra S, Sharma S, Grewal A, Kaul TK, Singh M R. Efficacy of intravenous fluid warming for maintenance of core temperature during lower segment Caesarean section under spinal anaesthesia. J Obstet Anaesth Crit Care 2011; 1: 73-77.

10. Butwick AJ, Lipman SS, Carvalho BM. Intraoperative Forced Air-Warming during Caesarean delivery under Spinal Anaesthesia does not prevent maternal hypothermia. Anesth Analg 2007; 105; 1413-19.

11. Najafianaraki A, Mirzaei K, Akbari Z, Macaire P. The effects of warm and cold intrathecal bupivacaine on shivering during delivery under spinal anaesthesia. Saudi J Anaesth 2012; 6: 336–40.

12. Bromage PR. Spread of analgesic solutions in the epidural space and their site of action: A statistical study. Br J Anaesth. 1962; 34:161–78.

13. Wrench IJ, Cavill G, Ward JE, Crossley AW. Comparison between alfentanil, pethidine and placebo in the treatment of post-anaesthetic shivering. Br J Anaesth 1997; 79: 541–42.

14. Kirkwood BR, Sterne JAC. Calculation of required sample size. Essential statistics. 2nd ed. Blackwell Science. 2003: pp 420-421.

15. Chung SH, Lee B-S, Yang HJ, Kweon KS, Kim H-H, Song J et al. Effect of preoperative warming during Caesarean section under spinal anesthesia. Korean J Anesthesiol 2012; 62: 454–60.

16. Ji-Won C, Duk-kyung K, Seung-Won L, Jung-Bo P, Gyu-Hong L. Efficacy of intravenous fluid warming during goal-directed fluid therapy in patients undergoing laparoscopic colorectal surgery: J Int Med Res 2016; 44: 606-12

17. De Mattia AL, Barbosa MH, Aché de Freitas Filho JP, De Mattia Rocha A, Pereira NHC. Warmed intravenous infusion for controlling intraoperative hypothermia. Rev. Latino-Am. Enfermagem. 2013; 21; 612-15

18. Mehta P, Theriot E, Mehrotra D, Patel K, Zarbalian A. Shivering following epidural anesthesia in obstetrics. Reg Anesth Pain Med. 1984; 9: 83–85

19. Lee JA, Chung SJ, Han SB, Chung TH, Park CH. The effect on onset time of warming local anesthetic for caudal block. Korean J Anesthesiol. 1997; 33: 1098–102.

20. Workhoven MN. Intravenous fluid temperature, shivering, and the parturient. Anaesth Analg. 1986; 65: 496–98

21. Woolnough M, Allam J, Hemingway C, Cox M, Yentis SM. Intra operative fluid warming in elective Caesarean section: A blinded randomized controlled trial. Int J Obstet Anesth 2009; 18: 346–51.

22. Kishore N, Payal YS, Kumar N, Chauhan N. In spinal anaesthesia for Caesarean section the temperature of bupivacaine affects the onset of shivering but not the incidence. J Clin Diagn Res 2016; 10: 18–21.

23. Lui AC, Poils TZ, Cicutti NJ. Densities of cerebrospinal fluid and spinal anaesthetic solution in surgical patients at body temperature. Can J Anaesth. 1998; 45: 297-303

24. Ponte J, Sessler DI. Extradurals and shivering: effects of cold and warm extradural saline injections in volunteers. Br J Anaesth. 1990; 64: 731-33

25. Birzat EG, Murat A, Michael E, Pinar KB, Senem G, Mahmut G et al. Effects of using 37°C bupivacaine on spinal block characteristics and Shivering. J Clin Anal Med 2016; 7: 89-93