Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/9wnf0y08

EFFECT OF TEMPERATURE VARIATION ON QUALITY OF SPINAL ANAESTHESIA USING 0.5% BUPIVACAINE IN PATIENTS UNDERGOING CESAREAN SECTION

Safia Iqbal[1*], Shumaila Motiwala[2], Sumreen Arif[3], Muneeba Arshad[4], Tooba Usman[5], Aftab Imtiaz[6]

[1*]MBBS, FCPS, Senior Registrar Department of Anaesthesia, Dow University Hospital, Karachi
[2] MBBS, FCPS, Senior Registrar Department of Anaesthesia, Dow University Hospital, Karachi
[3] MBBS, FCPS, Senior Registrar Department of Anaesthesia, Dow University Hospital, Karachi
[4] MBBS, FCPS, Assistant Professor Department of Anaesthesia, Dow University Hospital, Karachi
[5]MBBS, FCPS, Senior Registrar Department of Anaesthesia, Dow University Health Sciences, OJHA Campus
[6]MBBS, FCPS, Professor & Head of Department of Anaesthesia, KMDC &Abbasi Shaheed Hospital, Karachi

***Corresponding Author:** Dr. Safia Iqbal
*iqbal_safia_@hotmail.com

ABSTRACT

Background: Spinal anesthesia with intrathecal bupivacaine is widely used for cesarean sections. However, the temperature of bupivacaine may influence the onset, spread of sensory block, and incidence of shivering. Warming the anesthetic solution could enhance block characteristics and reduce perioperative discomfort.

Objective: To compare the effects of room temperature versus warmed intrathecal bupivacaine on sensory block levels and shivering incidence in patients undergoing cesarean section under spinal anesthesia.

Study Design & Setting: A randomized controlled trial conducted at Department of Anaesthesia, Abbasi Shaheed Hospital, Karachi from 14th June 2022 till 15th December 2022.

Methods: A total of 142 parturients scheduled for elective cesarean section were randomly allocated into two groups: Group A received room temperature bupivacaine (n=71), and Group B received warmed bupivacaine (n=71). Sensory dermatomal levels were assessed, and the incidence of shivering was recorded intraoperatively. Statistical analysis compared the onset, extent of sensory block, and shivering frequency between groups.

Results: The warmed bupivacaine group achieved higher sensory levels, with 21% and 61% of patients reaching T4 and T5 levels respectively, compared to 4% and 18% in the room temperature group. Shivering occurred less frequently in Group B (31%) compared to Group A (69%), though this difference did not reach statistical significance (p=0.111). The warmed group exhibited faster onset and better cephalad spread of sensory blockade.

Conclusion: Warming intrathecal bupivacaine significantly improves sensory block characteristics and tends to reduce the incidence of shivering during cesarean sections under spinal anesthesia. These findings support the clinical advantage of warming bupivacaine to enhance anesthetic efficacy and patient comfort.

Keywords: Bupivacaine, Cesarean Section, Sensory Block, Shivering, Spinal Anesthesia, Warming

INTRODUCTION

Spinal anaesthesia is widely regarded as the preferred technique for obstetric and infraumbilical surgeries due to its rapid onset, reliability, and safety profile.[1] A cesarean section is a surgical procedure in which the baby is delivered through an incision made in the abdominal wall and uterus. Although the procedure has become increasingly safe over the years, it still carries notable risks of maternal morbidity and mortality.[2] However, despite its extensive use, the quality and consistency of spinal anaesthesia outcomes are influenced by multiple factors, including baricity, patient positioning, dosage, volume, and more subtly, the temperature of the anaesthetic solution.[3]

Temperature plays a crucial role in determining the physicochemical properties of bupivacaine, which in turn affects its spread in the cerebrospinal fluid (CSF).[4] Warming the local anaesthetic solution reduces its viscosity, increases its diffusion rate, and can lead to a faster onset and wider spread of the block.[5] Conversely, colder solutions may lead to slower onset, reduced spread, and potentially incomplete or patchy anaesthesia. These physiological responses are particularly significant in obstetric anaesthesia, where time efficiency and complete sensory blockade are critical for both maternal and fetal safety.[6]

In cesarean sections, inadequate spinal anaesthesia can lead to intraoperative discomfort, increased need for supplemental analgesia, or conversion to general anaesthesia, all of which increase maternal anxiety and risk.[7] Spinal anaesthesia works by blocking sensory nerves, and simultaneously produces autonomic and motor blockade. While an effective spread of the anaesthetic agent is essential for optimal analgesia, an excessive cephalad spread can result in unwanted side effects. These may include sympathetic blockade leading to hemodynamic instability such as hypotension, nausea, and vomiting, as well as respiratory discomfort due to paralysis of the abdominal or intercostal muscles. Therefore, achieving an optimal level of sensory blockade while maintaining hemodynamic stability remains a critical goal in spinal anaesthesia for cesarean delivery.[8]

Bupivacaine is a long-acting amide-type local anaesthetic commonly used in spinal, epidural, and peripheral nerve blocks. It provides effective sensory and motor blockade, making it ideal for procedures such as cesarean sections due to its prolonged duration of action and stable hemodynamic profile.[9] The 0.5% bupivacaine refers to a hyperbaric solution containing 5 mg of bupivacaine per milliliter, commonly used in spinal anaesthesia for cesarean sections and lower abdominal surgeries. Its hyperbaric nature allows predictable spread in the cerebrospinal fluid, offering reliable and dense sensory and motor blockade with prolonged duration.[10]

According to Herniques, Karen, et al have shown that shivering was present in 57.5% patients who received room temperature Bupivacaine as compared to 32.5 % patients who received Bupivacaine at body temperature.[11]

Recent literature has begun exploring the impact of solution temperature on spinal anaesthesia efficacy; however, results remain inconclusive and somewhat conflicting due to variations in study design, temperature ranges, and clinical endpoints. This study aims to evaluate the effect of temperature variation on the quality of spinal anaesthesia using 0.5% bupivacaine in cesarean sections—a factor often overlooked in routine practice. Although international literature has explored temperature-related changes in anaesthetic efficacy, limited data exist from low-resource settings like Pakistan. Most local studies focus on dosage and baricity, with little emphasis on how temperature influences block onset, spread, and hemodynamic stability. By addressing this gap, our research may introduce a cost-effective, easily implementable strategy to enhance anaesthetic outcomes. The findings could help standardize spinal anaesthetic practices in obstetric care across Pakistan.

MATERIALS AND METHODS

After obtaining approval from the institutional ethical committee this study was conducted in the Department of Anaesthesia, Abbasi Shaheed Hospital, Karachi from 14th June 2022 till 15th December 2022. Informed consent was taken from all patients enrolled in the study. Patients scheduled for elective cesarean section under spinal anaesthesia in the gynecology operation theater were included. The sample size was calculated using the WHO sample size calculator with the following parameters: the frequency of shivering in patients who received bupivacaine at body temperature was 57.5%, while in those who received bupivacaine at room temperature, it was 32.5%. A power of 80% and a confidence interval of 95% were used for the calculation. Based on these values, the required sample size was determined to be 142 patients, with 71 patients allocated to each group (Group A and Group B). Non-probability consecutive sampling was used.

Only ASA I and II patients between the ages of 20 to 40 years who provided informed consent were enrolled. Patients who did not give consent, those with any contraindication to spinal anaesthesia, and patients with comorbidities such as hypertension, diabetes, pregnancy-induced hypertension (PIH), or gestational diabetes mellitus (GDM) were excluded. Additionally, patients weighing more than 120 kg or with a height less than 150 cm were also excluded from the study.

Participants were randomly allocated into two groups—Group A and Group B—using the lottery method. Group A received 12 mg of 0.5% bupivacaine at room temperature (26°C), while Group B received the same dose of bupivacaine warmed to 37°C using a water bath. Upon arrival in the operating theater, standard monitoring—three-lead ECG, noninvasive blood pressure, and pulse oximetry—was applied, and baseline vitals were recorded. After inserting a 20G intravenous cannula, patients were preloaded with 10 ml/kg of Ringer's lactate solution. All aseptic precautions were taken before administering spinal anaesthesia.

Spinal anaesthesia was performed in the sitting position using a midline approach at the L3–L4 interspace with a 25-gauge Quincke spinal needle. A dose of 2.2 ml (12 mg) of 0.5% bupivacaine was drawn into the syringe and injected over 10–15 seconds within 20 seconds of drug preparation, once free cerebrospinal fluid (CSF) flow was confirmed. The moment of drug injection was marked as zero time for the study, and all subsequent observations were recorded from that point. Patients were then positioned supine. The onset and progression of the sensory block were recorded, including the time to reach sensory level at L1, time to achieve T10 level, and the highest dermatomal level. Sensory block was assessed using a 25-gauge needle with the pinprick method, and responses were scored as follows: 0 = sharp pain, 1 = touch only, and 2 = no sensation. Motor block onset and the time required to reach the maximum motor block were recorded. The motor block was evaluated using the modified Bromage scale, where a score of 0 indicated the patient was able to move the hip, knee, and ankle; a score of 1 indicated the patient was unable to move the hip but could move the knee and ankle; a score of 2 indicated the patient was unable to move both the hip and knee but could still move the ankle; and a score of 3 indicated complete inability to move the hip, knee, and ankle. The time of onset of sensory block was defined as the interval from the completion of the injection of 0.5% bupivacaine into the subarachnoid space to the time when sensory block reached the L1 dermatome. The time of onset of motor block was measured as the interval from the completion of the injection to the achievement of Bromage grade 2 motor block. The highest sensory block referred to the maximum dermatomal level of sensory blockade attained. Shivering was assessed using the Crossley and Mahajan grading system for intraoperative shivering.

Patients were monitored throughout the surgery for the onset and severity of shivering, assessed using the Crossley and Mahajan grading system. All variables—including patient height, weight, time to onset of sensory and motor block (in seconds), highest sensory level, presence of shivering, and its severity—were documented in a pre-designed proforma.

SPSS version 23.0 was used to enter and analyze the collected data. Quantitative variables such as age, height, weight, time of onset of sensory block, time of onset of motor block, and time to reach the highest sensory block were reported as mean ± standard deviation or median (IQR). The time of onset of sensory block, time of onset of motor block, and highest sensory block were

compared between the two groups using the Mann-Whitney U test, while shivering was compared using the Chi-square test. Effect modifiers such as age, height, and weight were controlled through stratification. After stratification, the Mann-Whitney U test was applied for time of onset of sensory block, motor block, and highest sensory block, and the Chi-square test was used for shivering. A p-value ≤ 0.05 was considered statistically significant.

STUDY RESULTS

The baseline demographic characteristics of the study participants were comparable between the two groups. The mean age in Group A (Room Temperature) was 24.2 ± 4.5 years, while in Group B (Warmed) it was 24.3 ± 4.2 years. The mean height in Group A was 79.6 ± 6.1 cm and in Group B was 78.9 ± 6.5 cm. The mean weight in Group A was 161.2 ± 4.1 kg, whereas in Group B it was 162.1 ± 4.6 kg as given in table 1.

Table 1: Baseline Demographic Characteristics of Study Participants (n = 142)

Variable	Group A (Room Temp)	Group B (Warmed)
Age (years)	24.2 ± 4.5 Median: 24 (IQR:21–29)	24.3 ± 4.2 Median: 24 (IQR:22–28)
Height (cm)	79.6 ± 6.1 Median: 79 (IQR:70–88)	78.9 ± 6.5 Median: 78 (IQR:69–88)
Weight (kg)	161.2 ± 4.1 Median: 161 (IQR:158–164)	162.1 ± 4.6 Median: 162 (IQR:158–166)

The comparison of time parameters between the room temperature and warmed bupivacaine groups revealed statistically significant differences in all measured intervals. The mean time for onset of sensory block at L1 in Group A (Room Temperature) was 108.5 ± 12.3 seconds, whereas in Group B (Warmed) it was significantly shorter at 58.2 ± 6.5 seconds (p = 0.000). The time to reach the sensory block at the T10 level was also longer in Group A (111.2 ± 11.6 seconds) compared to Group B (57.4 ± 6.8 seconds), with a p-value of 0.000. Similarly, the time to reach the maximum sensory level was 121.5 ± 10.8 seconds in Group A and 61.3 ± 7.2 seconds in Group B (p = 0.000). The onset of motor block (Bromage 2) occurred at 107.6 ± 13.1 seconds in Group A versus 58.6 ± 6.2 seconds in Group B (p = 0.000). Lastly, the time to reach maximum motor block (Bromage 3) was 112.8 ± 12.7 seconds in Group A compared to 59.2 ± 6.9 seconds in Group B, again showing a significant difference (p = 0.000) as given in table 2

Table 2: Comparison of Time Parameters (in Seconds) Between Room Temperature and Warmed Bupivacaine Groups (n = 142)

Parameters (Time in seconds)	Group	Mean ± SD	Median (IQR)	P-Value
Time of onset of sensory block at L1	Group A (Room Temp)	108.5 ± 12.3	110 (90–120)	0.000*
	Group B (Warmed)	58.2 ± 6.5	60 (50–60)	
Time to reach sensory block at T10 level	Group A (Room Temp)	111.2 ± 11.6	115 (95–120)	0.000*
	Group B (Warmed)	57.4 ± 6.8	60 (50–60)	
Time to reach maximum sensory level	Group A (Room Temp)	121.5 ± 10.8	120 (110–130)	0.000*
	Group B (Warmed)	61.3 ± 7.2	60 (50–70)	
Time of onset of motor block (Bromage 2)	Group A (Room Temp)	107.6 ± 13.1	110 (90–120)	0.000*
	Group B (Warmed)	58.6 ± 6.2	60 (50–60)	
Time to reach max motor block (Bromage 3)	Group A (Room Temp)	112.8 ± 12.7	115 (90–120)	0.000*
	Group B (Warmed)	59.2 ± 6.9	60 (50–60)	

In Group B (Warmed Bupivacaine), higher sensory dermatomal levels were more frequently achieved, with 21% reaching T4 and 61% reaching T5. In contrast, Group A (Room Temperature) had lower block levels, with only 4% and 18% reaching T4 and T5, respectively. Mid to lower levels (T6–T8) were more common in Group A, indicating a more extensive sensory block in the warmed group as given in table 3.

Table 3: Comparison of the Highest Sensory Dermatomal Levels Achieved Between Room Temperature and Warmed Bupivacaine Groups (n = 142)

Sensory Dermatomal Level	Overall (n = 142)	Group A (Room Temp, n = 71)	Group B (Warmed, n = 71)
T4	18 (13%)	3 (4%)	15 (21%)
T5	56 (39%)	13 (18%)	43 (61%)
T6	39 (28%)	28 (39%)	11 (15%)
T7	28 (20%)	26 (37%)	2 (3%)
T8	1 (0.7%)	1 (1%)	0 (0%)

Shivering was observed more frequently in Group A (Room Temperature), where 11 patients (69%) experienced shivering, compared to 5 patients (31%) in Group B (Warmed). However, this difference was not statistically significant (p = 0.111).

Table 4: Comparison of Shivering Incidence Between Room Temperature and Warmed Bupivacaine Groups

Variable	Group	Frequency n (%)	P-Value
Shivering	Group A (Room Temp)	11 (69%)	0.111
	Group B (Warmed)	5 (31%)	

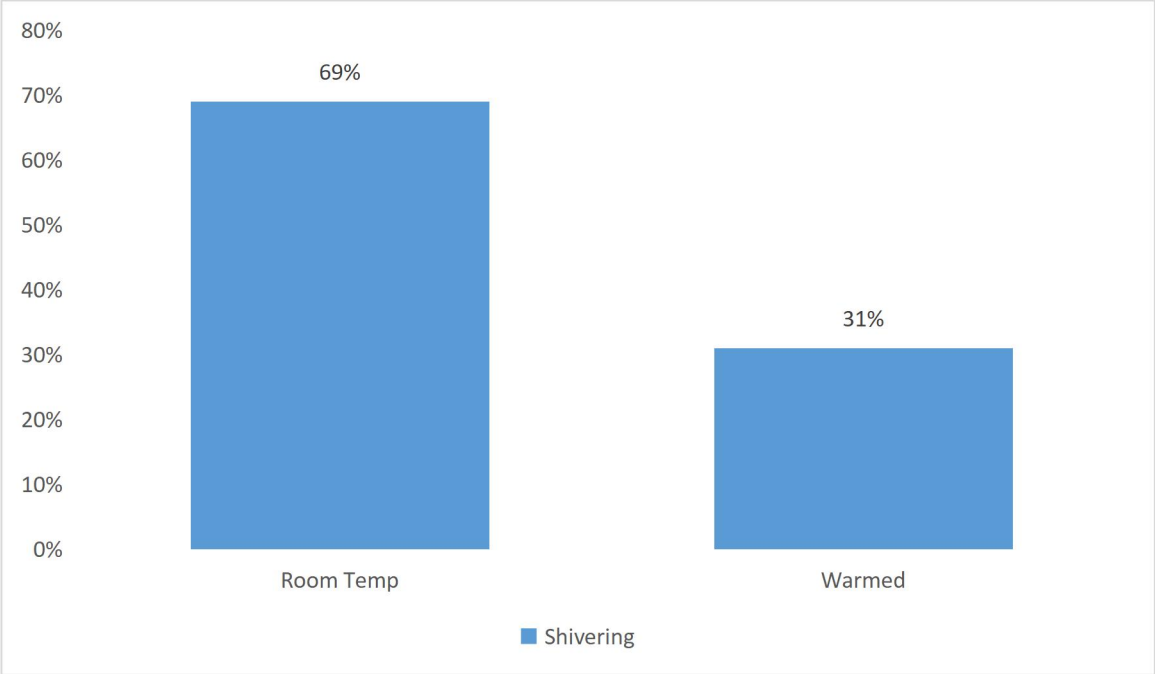

Figure 1: Comparison of Shivering Incidence Between Room Temperature and Warmed Bupivacaine Groups

DISCUSSION

Shivering is a common complication following spinal anesthesia, particularly during cesarean sections, and can lead to increased oxygen consumption and patient discomfort. Bupivacaine, a commonly used local anesthetic, has been associated with a significant incidence of shivering when administered at room temperature.[12] Warming the solution prior to administration may reduce this side effect by minimizing core body temperature fluctuations.[13] Various studies have evaluated methods to prevent shivering, but limited data exists on the direct comparison between warmed and room temperature Bupivacaine. Understanding the temperature effect on drug performance may help improve patient comfort and perioperative outcomes. This study aims to compare the onset times of sensory and motor blocks and the incidence of shivering between the two groups.

The present study demonstrated that warming intrathecal Bupivacaine significantly reduced the onset time of sensory block, improved the cephalad spread of anesthesia, and decreased the incidence of shivering among parturients undergoing cesarean section under spinal anesthesia. Our findings are consistent with those of Aydin et al. (2011), who reported a faster readiness for surgery in the warmed Bupivacaine group (5.07 ± 0.39 minutes vs. 10.37 ± 1.13 minutes, $p<0.01$), with quicker bilateral pinprick loss and more rapid cephalad spread at 5 and 10 minutes ($p<0.01$, $p=0.037$). Similarly, our study found that higher dermatomal sensory levels like T4 and T5 were achieved more frequently in the warmed group compared to room temperature (21% and 61% vs. 4% and 18%, respectively), indicating a more effective sensory block.[14]

In terms of shivering, the current study revealed a marked reduction in the warmed group (31%) compared to the room temperature group (69%), although $p=0.111$ suggests borderline statistical significance. This trend mirrors the findings of Feng et al. (2021), who observed a significantly higher shivering incidence with room temperature Bupivacaine (66.7% vs. 20.5%, $p<0.001$). They further identified Bupivacaine as an independent predictor of shivering (OR=7.78, 95% CI: 2.94–20.59, $p<0.01$).[15] Al-Mandhari et al. (2019) also reported significantly lower shivering in the warmed group (14%) compared to the room temperature group (62%, $p=0.0001$), reinforcing the thermal influence of the anesthetic solution.21

Although Kishore et al. (2016) found no statistically significant difference in shivering incidence among groups using different temperature solutions ($p=0.858$), the earliest onset was noted in the coldest solution group (T4: 9.87 ± 1.82 minutes vs. T22: 14.27 ± 3.02 minutes and T37: 12.16 ± 2.89 minutes, $p=0.0001$), supporting our finding of delayed onset in the warmed group.[16] Our results align with Thakur et al. (2023), who demonstrated a lower shivering rate (9.46%) in the group receiving intrathecal bupivacaine with fentanyl, compared to 41.89% with plain Bupivacaine. Though the mechanism differs, both studies affirm the role of adjunctive or altered formulation in reducing shivering.[17] Furthermore, Javed et al. (2014) found a rapid onset of sensory block with isobaric Bupivacaine (77% achieving T6 level within 3 minutes) and noted a more pronounced hypotensive response compared to the hyperbaric form. Similarly, our warmed group experienced faster block onset and higher sensory levels, albeit without significant hemodynamic instability.[19] Interestingly, while Shahid et al. (2022) focused on adding dexamethasone to prolong analgesia duration (359.73 ± 8.02 minutes vs. 182.30 ± 7.72 minutes), they did not assess thermal modification, leaving a gap filled by our study in demonstrating that warming Bupivacaine may enhance onset and quality of block without necessarily affecting analgesia duration.[20]

Contrary to our findings, Naveena et al. (2025) observed no significant difference in sensory onset (T10 in 3.22 ± 0.85 vs. 3.54 ± 0.92 minutes) or maximum block level (T6 vs. T7) between groups using different thermal preparations. However, their focus was on dermatomal levels rather than shivering, and their sample size and methods may differ from ours.[22] Finally, Khan et al. (2023) highlighted greater hypotension in room temperature group at all time intervals post-spinal anesthesia ($p<0.05$), which supports the idea that warmed Bupivacaine may contribute to more stable hemodynamic profiles—although in our study, blood pressure data were not the primary outcome.[18]

This study used a randomized approach with equal distribution of participants in both intervention groups, enhancing internal validity. Standardized anesthesia protocols were followed, ensuring consistency in procedure. Objective measurement tools such as Bromage scale and dermatomal levels were employed. However, the study was limited to a single center, which may affect generalizability. The sample size, although adequate, may not detect smaller effect sizes. Patient-reported outcomes such as thermal comfort or satisfaction were not assessed.

CONCLUSION

Warmed Bupivacaine significantly reduced the onset time of sensory and motor block and decreased the incidence of intraoperative shivering. It proved to be more effective and comfortable for patients undergoing elective cesarean section under spinal anesthesia. Incorporating warmed Bupivacaine in routine practice may enhance anesthetic quality and patient experience.

REFERENCES

1. Pirenne V, Dewinter G, Van de Velde M. Spinal anaesthesia in obstetrics. Best Practice & Research Clinical Anaesthesiology. 2023 Jun 1;37(2):101-8.
2. Dhakal-Rai S, van Teijlingen E, Regmi P, Wood J, Dangal G, Dhakal KB. A brief history and indications for cesarean section. Journal of Patan Academy of Health Sciences. 2021 Oct 10;8:e1-0.
3. Garg B, Bansal T, Mehta N, Sharan AD. Patient positioning in spine surgery: what spine surgeons should know?. Asian Spine Journal. 2023 May 25;17(4):770.
4. Elsharkawy RA, Messeha MM, Elgeidi AA. The influence of different degrees of temperature of intrathecal levobupivacaine on spinal block characteristics in orthopedic surgeries: a prospective randomized study. Anesthesia Essays and Researches. 2019 Jul 1;13(3):509-14.
5. Haberer JP, Dalens BJ. Local anesthetics and additives. InPediatric regional anesthesia 2019 Aug 15 (pp. 91-126). Routledge.
6. Zaza KJ, Hopf HW. Thermoregulation: Normal physiology, anesthetic effects, and perioperative considerations. InPharmacology and Physiology for Anesthesia 2019 Jan 1 (pp. 300-310).
7. Stav M, Matatov Y, Hoffmann D, Heesen P, Gliesche V, Binyamin Y, Ioscovich A, Eidelman LA, Orbach-Zinger S. Incidence of conversion to general anaesthesia and need for intravenous supplementation in parturients undergoing caesarean section under spinal anaesthesia: a retrospective observational study. Acta Anaesthesiologica Scandinavica. 2023 Jan;67(1):29-35.
8. Otto KA. Physiology, pathophysiology, and anesthetic management of patients with neurologic disease. Veterinary Anesthesia and Analgesia: The Fifth Edition of Lumb and Jones. 2015 Apr 29:557-83.
9. Yu S, Wang B, Zhang J, Fang K. The development of local anesthetics and their applications beyond anesthesia. Int J Clin Exp Med. 2019 Jan 1;12(12):13203-20.
10. Tubog TD, Ramsey VL, Filler L, Bramble RS. Minimum effective dose (ED50 and ED95) of intrathecal hyperbaric bupivacaine for cesarean delivery: a systematic review. AANA J. 2018 Oct 1;86(5):348-60.
11. Olawin AM, M Das J. Spinal Anesthesia. In: StatPearls. StatPearls Publishing, Treasure Island (FL); 2021. PMID: 30725984.
12. Ferede YA, Aytolign HA, Mersha AT. "The magnitude and associated factors of intraoperative shivering after cesarean section delivery under Spinal anesthesia'': A cross sectional study. Annals of Medicine and Surgery. 2021 Dec 1;72:103022.
13. Blumenberg A. Dosing heat: expected core temperature change with warmed or cooled intravenous fluids. Therapeutic Hypothermia and Temperature Management. 2021 Dec 1;11(4):223-9.

14. Aydin, G. & Süslü, A & Özlü, O & Aksoy, Mustafa & Polat, Reyhan. (2011). The Influence of Temperature on Spread of Intrathecal Levobupivacaine. The Internet Journal of Anesthesiology. 29. 1-6.
15. Feng G, Wang Y, Feng J, Luo X, Li C, Yao S. The relationship between core temperature and perioperative shivering during caesarean section under intrathecal anesthesia with bupivacaine and ropivacaine: a randomized controlled study. Journal of anesthesia. 2021 Dec;35(6):889-95.
16. Kishore N, Payal YS, Kumar N, Chauhan N. In spinal anaesthesia for cesarean section the temperature of bupivacaine affects the onset of shivering but not the incidence: a randomized control trial. Journal of Clinical and Diagnostic Research: JCDR. 2016 Jan;10(1):UC18.
17. Thakur N, Balachander H, Rudingwa P, Panneerselvam S. Shivering and changes in body temperature in patients undergoing caesarean section under spinal anaesthesia with bupivacaine vs bupivacaine and fentanyl: A randomized clinical study. Journal of Anaesthesiology Clinical Pharmacology. 2023 Jan 1;39(1):67-73.
18. Khan MK, Hafiz A, Feroze F, Tahir AA, Farooq S, Faheem MS. Comparison of hemodynamic effect caused by intrathecal low dose administration of 0.5% against 0.75% hyperbaric bupivacaine in patients undergoing lower limb surgery under unilateral spinal anaesthesia. Journal of Ayub Medical College Abbottabad. 2023 Dec 22;35(4):549-52.
19. Javed KH, Ishrat ZA, Akhtar N, Ijaz B. Comparative study of intrathecal 0.5% isobaric versus 0.5% hyperbaric bupivacaine in same volume and dose to assess the quality of spinal anaesthesia and haemodynamic changes occurring during cesarean section. Pakistan J Med Health Sci. 2014 Apr 1;8(2):407-10.
20. Shahid M, Sibtain A, ul Islam M, Ahmed I, Khan B, Shakil R, Ali FA. Comparison of the Effect of Intrathecal Hyperbaric 0.5% Bupivacaine Alone and With Addition of Dexemedetomidine on First Analgesic Request in Post-Operative Care Unit Following Elective Cesarean Section: Bupivacaine alone and with addition of Dexemedetomidine on duration of anesthesia following c-section. Pakistan BioMedical Journal. 2022 Jan 31:54-8.
21. Al-Mandhari KM, Al-Shukaili AA, Younis B, Lad S, Khan RM, Kaul N. Effects of 0.5% heavy bupivacaine at room versus body temperature on shivering and analgesia after spinal anesthesia in patients undergoing cesarean section. Indian Journal of Pain. 2019 May 1;33(2):77-80.
22. Naveena P, Naveenkumar P, Kumar A, Shanmugasundaram S, Choudhary AK, Periasamy P. Effect of injection speed of hyperbaric bupivacaine 0.5% in spinal anesthesia on block quality and hemodynamic changes in elective cesarean sections. Anaesthesia, Pain & Intensive Care. 2025 Feb 4;29(1):105-11.