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Comparing Warm and Cold Bupivacaine for Cesarean Section Spinal Anesthesia

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Abstract: Spinal anesthesia is widely favored for cesarean sections due to its benefits over general anesthesia, but shivering remains a common issue. This study compares warm and cold storage of heavy bupivacaine for spinal anesthesia in cesarean delivery. One hundred parturient women were divided into groups receiving warm or cold bupivacaine, and vital signs, shivering, and block duration were assessed. While no significant differences were found in vital signs or block duration, shivering incidence was notably higher in the cold bupivacaine group. These findings highlight the importance of considering the temperature of local anesthetic solutions to mitigate shivering, indicating a need for further exploration of contributing factors. Optimizing bupivacaine temperature may enhance patient comfort and safety during cesarean sections. Further research could elucidate the multifactorial nature of shivering during spinal anesthesia, improving obstetric anesthesia practices.

Keywords: Warm, Cold, Bupivacaine, Cesarean Section, Spinal Anesthesia

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1. Introduction

Spinal Anesthesia: Subarachnoid blockade is a form of regional anesthesia that involves numbing the lower half of the body by administering an anesthetic agent into the subarachnoid space surrounding the spinal cord. This technique is commonly used in various surgical procedures to provide pain relief and muscle relaxation without the need for general anesthesia [1]. In adults, the spinal cord typically ends at the L1-L2 level, while in infants, it extends to L3. The Dural sac on the other hand, reaches down to S2 in adults (and lower in children). This specific region between L2 and S2 contains cerebrospinal fluid (CSF) along with the lumbar and sacral nerve roots, collectively known as the cauda equina. To ensure the accurate administration of spinal anesthesia, healthcare providers use anatomical landmarks such as the iliac crests to guide them. For instance, the intercristine or Toffler's line marks the L3/L4 interspace, aiding in the identification of the appropriate injection site. It is crucial to avoid any errors in identifying the correct level, as mistakenly inserting the needle at the L2/L3 interspace can result in severe consequences. This includes unintentional penetration of the spinal cord or the conus medullaris, potentially causing intense pain and permanent damage. The distance between the skin surface and the subarachnoid space is approximately 6 cm in an individual of average build, highlighting the importance of precision in needle placement.

As the needle passes through various structures before reaching the subarachnoid space, patients may experience sensations like a click upon piercing the dura. Additionally, they might report paresthesia in the lower extremities, indicating the proximity of the needle to nerve pathways. Once the local anesthetic solution is injected, it diffuses within the

subarachnoid space, providing effective anesthesia to areas such as the lower limbs, external genitalia, and abdominal organs [2].

Anatomy Exploration:

Once the patient is comfortably positioned, the L3-4 interspace is pinpointed by utilizing a well-known guide known as Tuffier's line, and subsequently, a localized area of raised skin (wheal) is created right at the midpoint of the identified interspace. In the realm of midline approach, precisely at the level of the interspace, a needle is carefully introduced in a central direction. By inclining the needle at a 15-degree angle towards the head, it is gently advanced until a distinct clicking or popping sensation is perceived, typically occurring at a depth ranging between 4-6 cm (3) beneath the skin surface. On the other hand, the paramedian technique involves inserting the needle approximately 1 - 2 centimeters away from the upper edge of the spinous process. The needle is initially inserted perpendicular to the skin, making contact with the lamina of the vertebra. Subsequently, a slight withdrawal is followed by reinserting the needle with a 15-degree inward and 30-degree upward adjustment, enabling it to traverse over the lamina through the interlaminar space. Advancement continues until another distinctive click or pop is felt, indicating the penetration of the dura mater. Once a smooth flow of cerebrospinal fluid (CSF) is observed, the desired quantity of anesthetic solution can be injected into the region [3].

Technique:

When it comes to the technique of performing a lumbar puncture for subarachnoid block, there are two main positions that can be utilized - the sitting position or the lateral decubitus position [4].

Sitting position :tends to make it easier to locate the midline, a benefit that proves especially useful when dealing with obese patients. Moreover, this position is often linked to a quicker onset of action [5], which can be advantageous in certain scenarios. On the other hand, assuming a lateral decubitus position is known to result in a slower onset of the block, especially if the patient remains fully on their side until the block reaches its full effect. This position variation adds an interesting dynamic to the procedure, offering different timing and efficacy outcomes based on the chosen approach. It is essential for healthcare providers to carefully consider these factors when deciding on the most suitable position for lumbar puncture, weighing the pros and cons of each to ensure optimal outcomes for the patient.

Performing a spinal anesthetic at the L3/4 interspace involves utilizing a 25G or smaller pencil-point needle, typically with the iliac crests aligning with the spinous process of L4, although individual variances exist. When administering the anesthetic solution, ensure the orifice of the needle is directed upwards towards the head. Following the injection, reposition the patient onto their back with a slight leftward incline or support. In cases where hyperbaric Local Anesthesia solutions are employed, it becomes crucial to maintain the cervical spine in an elevated position, possibly with the aid of a pillow, to prevent the dispersion of Local Anesthesia towards the cervical dermatomes [5].

There are only a handful of definite contraindications when it comes to neuraxial blockade, each playing a crucial role in determining the suitability of this medical procedure. Among these significant contraindications are patient refusal, localized sepsis, and an allergic reaction to any of the medications intended for use. Moreover, the inability of a patient to remain still during needle insertion, which could potentially lead to damage to neural structures, and elevated intracranial pressure, which might theoretically increase the risk of brainstem herniation, must also be regarded as absolute contraindications to employing a neuraxial approach [6,7]. On the other hand, there are relative contraindications that need to be taken into account as well. For instance, individuals with spinal stenosis may face a higher likelihood of experiencing neurological complications following neuraxial blockade [8]. Furthermore, patients with a history of spine surgery do not necessarily have an elevated risk of such complications after neuraxial blockade; however, factors such as postsurgical anatomy and the presence of scar tissue can influence the outcome [9]. Lastly, .Patients diagnosed with Multiple Sclerosis (MS) may demonstrate heightened sensitivity to neuraxial local anesthetics, leading to a prolonged duration of both motor and sensory blockade. This increased sensitivity can result in a more significant impact on the patient's nervous system,

affecting their movement and sensation for an extended period. The unique response of MS patients to these anesthetics necessitates careful monitoring and management to ensure optimal outcomes and minimal complications during medical procedures. Healthcare providers must be particularly vigilant when administering neuraxial local anesthetics to individuals with MS to prevent any potential adverse effects and ensure patient safety. Aortic Stenosis or Fixed Cardiac Output can present challenges in the context of spinal anesthesia due to the uncertain reduction in systemic vascular resistance, which could compromise coronary perfusion [10]. This uncertainty often leads healthcare providers to be cautious when considering spinal anesthesia for preload-dependent patients, opting instead for alternative approaches to avoid any risks of decreased coronary perfusion that could be detrimental to the patient's cardiac health. The need to balance the benefits of spinal anesthesia with the potential risks in such patients underscores the importance of individualized care and thorough risk assessment in clinical practice.

Hypovolemic patients, similar to those who are preload dependent, may experience an amplified hypotensive response to the vasodilatory effects of neuraxial blockade. This exaggerated response highlights the need for close monitoring and proactive management to prevent complications such as severe drops in blood pressure that could compromise organ perfusion and overall patient well-being. Healthcare providers must exercise caution and implement strategies to mitigate the risks associated with neuraxial blockade in hypovolemic patients, ensuring that the benefits of the procedure outweigh any potential adverse effects.

The presence of Inherited Coagulopathy can further complicate the use of neuraxial local anesthetics, requiring healthcare providers to exercise additional caution and consider alternative approaches to minimize the risk of bleeding complications. Due to the inherent coagulation issues in these patients, special attention must be paid to coagulation parameters and clotting function before and during procedures involving neuraxial blockade. In cases of Infection, healthcare providers must carefully evaluate the risks and benefits of neuraxial blockade, considering the potential impact of the infection on the patient's overall health and the likelihood of complications related to the procedure. Close monitoring, infection control measures, and a thorough risk assessment are crucial in managing patients with concurrent infections to minimize adverse outcomes and ensure patient safety throughout the treatment process.

Factors influencing the height of blocks can be attributed to various elements like drug, patient, and procedural factors, which play a crucial role in determining the distribution of local anesthetic within the intrathecal space. Some of these factors hold more significance in clinical settings than others due to their impact [11].

1- drug factors, one important aspect to consider is baricity, which represents the ratio of the density of a local anesthetic solution to that of cerebrospinal fluid (CSF). Since density exhibits an inverse relationship with temperature, the baricity of a local anesthetic solution is typically defined at 37 co. The density of CSF is 1.00059 g/L [12], Local anesthetic solutions matching the density of CSF are termed isobaric, while those with higher density are called hyperbaric, and those with lower density are known as hypobaric solutions [13]. Hyperbaric solutions tend to spread towards the dependent areas of the spinal canal, whereas hypobaric solutions have a preference for nondependent regions [14].

Dose, Volume, and Concentration of drug play a crucial role in the administration of local anesthetics. The relationship between dose, volume, and concentration is complex and interconnected, with dose being the most critical factor in determining the spread of the anesthetic agent within the body. When comparing the impact of volume and concentration, dose emerges as the most reliable determinant of local anesthetic spread, influencing block height. This is particularly true for isobaric and hypobaric local anesthetic solutions, where the dose has a more pronounced effect on the outcome than volume or concentration [15].

2-Patient-related factors also play a significant role in the efficacy of local anesthesia. One such factor is the volume of cerebrospinal fluid (CSF), which has a notable influence on peak block height and the regression of sensory and motor blockade [16]. Additionally, advanced age is associated with an increase in block height, as older patients experience a decrease in CSF volume and an increase in its specific gravity. Moreover, nerve roots in the elderly population tend to be more sensitive to local anesthetics, further affecting the overall effectiveness of the anesthesia in this demographic [17].

Pharmacology:

Bupivacaine is protein-bound amide local anesthetic characterized by a slow onset primarily due to its relatively high pKa value. This remarkable drug is deemed suitable for medical procedures that span a duration of up to 2.5 to 3 hours. Interestingly, at standard room temperature, plain Bupivacaine actually exhibits a slightly hypobaric nature when compared to cerebrospinal fluid (CSF). Furthermore, the recovery patterns observed with the use of minimal doses of Bupivacaine seem to mirror that of lidocaine, hence making low-dose Bupivacaine a preferred choice for outpatient procedures [18]. It is intriguing to note that temperature variations do not exert any discernible impact on the chemical composition and structure of Bupivacaine [19].

Complications:

1. Hypotension, characterized by systolic blood pressure dropping below 90 mm Hg, is prone to manifest due to various factors such as experiencing a peak block height equal to T5, patient 40 years old or older, having a baseline systolic blood pressure below 120 mm Hg, receiving a combination of spinal and general anesthesia, undergoing a spinal puncture at or above the L2-L3 interspace, and incorporating fentanyl into the local anesthetic [20]. Furthermore, hypotension, defined as a decrease in mean arterial blood pressure exceeding 30%, is distinctly linked to chronic alcohol consumption, a history of hypertension, body mass index (BMI), and the urgency level of the surgical procedure [21]. Common symptoms of hypotension in the context of axial anesthesia encompass not only nausea but also vomiting, dizziness, and shortness of breath. In the effort to prevent hypotension induced by vasodilatation, one can consider administering a prophylactic infusion of colloid or crystalloid (known as "preloading") while performing the neuraxial block [22]. This proactive approach can help mitigate the risk of hypotension and its associated complications.
2. Post-Dural-puncture headache.
3. Cauda Equina.
4. Cardiac Arrest.
5. spinal Canal Hematoma.
6. Shivering : Is a common complication that manifests in as many as 55% of patients [23], posing a significant challenge in the clinical setting. The experience of shivering, a prevalent consequence, not only causes discomfort to the patient but also poses obstacles in effectively monitoring vital signs such as electrocardiogram readings, blood pressure fluctuations, and oxygen saturation levels [24]. Furthermore, the implications of shivering extend beyond mere physical discomfort, as they include metabolic and hemodynamic repercussions. These include heightened energy expenditure by the cardiac systems, escalated levels of oxygen consumption coupled with increased carbon dioxide production, and an overall rise in cardiac workload [25]. Particularly within the obstetrical demographic, these effects are especially troublesome [26]. The primary culprits behind shivering in surgical patients encompass various factors such as intraoperative temperature decline, augmented sympathetic nervous system activity, pain signals, systemic release of pyrogens, and the direct impact of the local anesthetic's temperature on thermosensitive neurons within the spinal cord [27]. The intricate network of the central nervous system (CNS), which encompasses the spinal cord, acts as a critical recipient of thermal cues from the body, playing a pivotal role in maintaining and regulating body temperature. Despite numerous research endeavors aimed at addressing post-spinal anesthesia shivering [28], the precise root causes of this phenomenon and the most effective preventive measures remain elusive, leaving a significant gap in understanding within the medical community.

Shivering that occurs as a result of neuraxial anesthesia can potentially find relief through the application of warmth to the sentient skin. This method works by enhancing the transmission of thermal signals from the skin to the central regulatory system, ultimately leading to an increase in the level of core hypothermia that can be tolerated. Given that about 20% of thermoregulatory control comes from the entire skin surface and roughly 10% from the lower body [29], warming the sentient skin is expected to only offset minor decreases in

core temperature. The medications proven effective in managing post-anesthetic tremors have also shown utility in addressing shivering during regional anesthesia. These pharmaceutical options encompass meperidine (administered intravenously [IV] or epidurally at a dosage of 25 mg), clonidine (at a dose of 75 μg IV) [30], dexmedetomidine [31], ketanserin (given at 10 mg IV), and magnesium sulfate (administered at 30 mg/kg IV) [32].

2. Methods

After obtaining the scientific council of anesthesia, prospective, randomized, clinical trial was carried out in obstetric operation theaters of Baghdad teaching hospital, during the period from 1st July 2017 to 30 December 2019. 100 patients have been enrolled in this study. And all patients receiving spinal anesthesia, scheduled to have elective caesarian section. Fifty patients received spinal anesthesia by using heavy bupivacaine 2ml 0.5 %(10 mg) stored at room temperature (23-25C°) and other Fifty patient receive heavy bupivacaine 2ml 0.5 %(10 mg) stored at (4 - 6 C°) . Detailed history was taken from each patient, age, height, weight and medical history. General examination was performed and vital signs measurement are recorded in all Patient in both group were ,in addition to all patient were ASA II, Age: 20-40 yrs Weight.: 60-90 Kg Hight.: 150-170 cm. Elective caesarian section. On the other hand Patient refusal or when there is Contraindication of regional anesthesia or Hypersensitivity to amide local anesthesia ,Hypertension ,Cardiac disease and Renal disease all are excluded from this thesis.

Spinal anesthesia was performed as following: Spinal anesthesia was carried out in the following manner: Initially, after obtaining the necessary written consent from the patient, they were carefully positioned under standard monitoring procedures, and two wide bore intravenous cannulas were inserted to facilitate the administration of medications. A preload of 10 ml/kg of 0.9% N/S solution was then given to the patient within a time frame of 15 to 30 minutes, ensuring proper hydration and preparation for the anesthesia. Throughout the procedure, oxygen was consistently delivered to the patient to support their respiratory functions and maintain adequate oxygen levels in the body. The spinal anesthesia technique was executed with the patient in a seated position, following strict aseptic protocols to minimize the risk of infections. The insertion levels chosen for accessing the intervertebral space were either L2-L3 or L3-L4, using a midline approach to accurately target the desired location. Utilizing a 25-gauge needle, the subarachnoid space was successfully reached, and upon confirmation of cerebrospinal fluid (CSF) presence, the anesthetic drug (heavy bupivacaine) was carefully injected to induce the desired effects. Following the administration of the medication, the patient was then gently repositioned into a supine position with left uterine displacement, ensuring optimal conditions for the procedure to unfold smoothly. Additionally, the operating room temperature was meticulously regulated and maintained at a constant 25°C to create a comfortable and stable environment for both the patient and the medical team.

Sensory and motor block assessment: The evaluation of sensory block involved a unique method of gauging cold sensation loss through the application of a cold sponge, while the assessment of motor block was carried out using a specialized scoring system known as modified Bromage's score, as illustrated in Figure (1) , which provided a comprehensive analysis of both sensory and motor functions in a creative and innovative manner.

Data Collection: Base line hemodynamic variables were recorded: oxygen saturation, pulse rate and blood pressure, every 5 min, duration of block was recorded, Shivering was graded by yes or no . Hypotension was treated with 5–10 mg of ephedrine IV, nausea and vomiting treated with 10mg metoclopramide IV, shivering was treated by tramadol (100 mg). Chi-square test was used for categorical variables, independent sample T-test for numerical and normally distributed variables, and binary logistic regression models was used to investigate the odd's ratio of each variable.

3. Result and Discussion

In this fascinating and innovative dual-arm experimental investigation, a total of 100 patients were enrolled, all of whom were undergoing a caesarian section operation. Among these patients, 50 individuals were administered worm bupivacaine, while the remaining 50 received cold bupivacaine maintained at a temperature range of 4 to 6 co. As the analysis delved into the comparison between the effects of cold and worm bupivacaine within the entire cohort of 100 participants, it lack of any statistically significant disparities between the two. The duration of block induction manifested remarkably similar outcomes in both bupivacaine groups, with timings of 3.32 ± 0.36 minutes for the worm variant and 3.31 ± 0.36 minutes for the cold one, showcasing a statistically insignificant variance (p-value >0.05). Furthermore, the examination of the highest systolic blood pressure levels disclosed closely aligned values for the worm and cold bupivacaine factions, registering at 122.80 ± 6.07 mmHg and 122.10 ± 5.54 mmHg, respectively. Similarly, the readings for the lowest systolic blood pressure mirrored this trend ,the mean highest diastolic blood pressure exhibited a slightly elevated figure in the worm bupivacaine recipients compared to their cold bupivacaine counterparts, with values of 80.30 ± 7.65 mmHg and 78.50 ± 6.08 mmHg, respectively. This pattern also extended to the lowest diastolic blood pressure readings and the pulse rate measurements. Notably, the only parameter where a slight discrepancy emerged was in the O2 saturation levels, with the cold bupivacaine group showcasing a marginally higher saturation percentage of 98.62% ± 0.910% in contrast to the 98.52% ± 1.015% observed in the worm bupivacaine cohort. (Table.1)

Table 1. Distribution of variables according to temperature of bupivacaine received in patients with shivering (N=100).

Variable	Temperature		P value
	Worm	Cold	
	Mean	Mean	
Duration of block	3.32	3.31	0.891
Highest Systolic BP	122.80	122.10	0.549
Highest Diastolic BP	80.30	78.50	0.196
Lowest Systolic BP	97.60	95.70	0.266
Lowest Diastolic BP	62.60	61.90	0.491
Pulse Rate	92.28	91.50	0.564
O2 Saturation	98.52	98.62	0.604

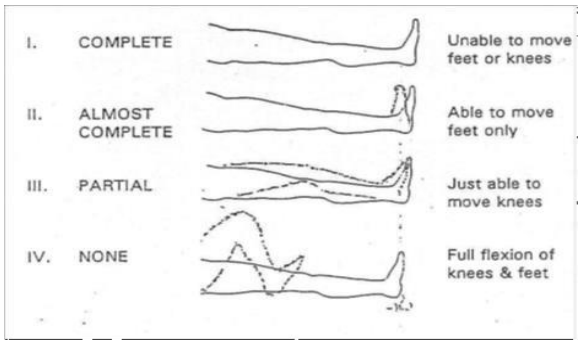

Figure 1. Bromage's score.

In terms of the distinctions between means of variables and shivering in patients who were administered warm bupivacaine, the findings indicated that there are only minimal variances among the variables. Among the patients who experienced shivering, the pulse rate exhibited a statistically significant higher mean of 94.81 ±6.39 bpm, in contrast to 91.09 ±5.90 bpm in patients who did not shiver. While the other factors did not demonstrate any statistical variance. The duration of the block was marginally longer in patients with shivering, measuring at 3.35 ±0.357 min, compared to 3.30 ±0.364 min in patients without shivering. Assessment of systolic and diastolic blood pressure readings took place post-anesthesia and was documented twice, once for the highest reading and once for the lowest reading, adding depth to the comprehensive analysis of patient responses to warm bupivacaine administration. During the study, measurements were taken every 15 minutes, capturing the highest systolic blood pressure at 125.0 ±7.071 mmHg for patients experiencing shivering, slightly higher than the 121.76 ±5.34 mmHg recorded for those without shivering. In contrast, the highest diastolic reading for shivering patients was 80.31 ±7.40 mmHg, showing a minimal difference compared to 80.29 ±7.86 mmHg for non-shivering patients. Furthermore, the lowest systolic reading for shivering individuals stood at 98.44 ±11.06 mmHg, slightly elevated from the 97.21 ±8.09 mmHg seen in patients not experiencing shivering. Notably, the lowest diastolic reading displayed a statistically significant variance, with a more pronounced contrast observed between the 64.06 ±4.55 mmHg for shivering patients and the 61.91 ±5.36 mmHg for those without shivering. Additionally, oxygen saturation levels remained relatively consistent across both groups, with readings of 98.69% ±1.014% and 98.44% ±1.02% recorded for shivering and non-shivering patients, respectively.

Table 2. Distribution of variables according to shivering in patients who received worm bupivacaine (n=50).

Variable	Shivering		P value
	Yes	No	
	Mean	Mean	
Duration of block	3.35	3.30	0.620
Highest Systolic BP	125.00	121.76	0.079
Highest Diastolic BP	80.31	80.29	0.994
Lowest Systolic BP	98.44	97.21	0.658
Lowest Diastolic BP	64.06	61.91	0.173
Pulse Rate	94.81	91.09	0.048
O2 Saturation	98.69	98.44	0.429

In terms of the distinctions between the average values of various factors and the occurrence of shivering in individuals who were administered cold bupivacaine, it was found that only the pulse rate exhibited a statistically significant higher mean in patients experiencing shivering, with a value of 93.88 ±6.82 beats per minute, in contrast to patients who did not shiver, having a pulse rate of 89.31 ±6.92 beats per minute. The duration of the nerve block was slightly lengthier in patients who did not exhibit shivering, recorded at 3.38 ±0.44 minutes, as opposed to 3.22 ±0.418 minutes in patients who did shiver. Although there was a statistically significant difference noted in the highest systolic blood pressure readings, the disparity in this variable was more pronounced compared to others, with values of 122.29 ±5.103 mmHg in patients with shivering and 121.92 ±6.013 mmHg in those without shivering. Likewise, the highest diastolic blood pressure was measured at 79.79 ±5.80 mmHg in patients experiencing shivering, showing a slight variance from the reading of 77.31 ±6.202 mmHg in non-shivering patients. The lowest systolic blood pressure recorded in individuals who shivered was 95.00 ±7.51 mmHg, while it was slightly higher at 96.35 ±8.31 mmHg in patients who did not shiver. Similarly, the lowest diastolic blood pressure was marginally lower at 61.88 ±4.84 mmHg in shivering patients compared to 61.92 ±5.11 mmHg in those without shivering. Oxygen saturation levels were found to be very similar in both groups, with percentages of 98.58% ±1.018% and 98.56% ±0.797% observed in individuals experiencing shivering and those who did not shiver, respectively. (Table 3)

Table 3. Distribution of variables according to shivering in patients who received cold bupivacaine (n=50).

Variable	Shivering		P value
	Yes	No	
	Mean	Mean	
Duration of block	3.22	3.38	0.177
Highest Systolic BP	122.29	121.92	0.817
Highest Diastolic BP	79.79	77.31	0.151
Lowest Systolic BP	95.00	96.35	0.552
Lowest Diastolic BP	61.88	61.92	0.973
Pulse Rate	93.88	89.31	0.023
O2 Saturation	98.58	98.65	0.785

There was a grand total of 40 individuals, representing 40.0% of the study participants, who experienced shivering during the experiment. Out of these, 16 individuals (32.0%) were administered worm bupivacaine, while 24 individuals (48.0%) received cold bupivacaine. Surprisingly, no statistically significant correlation was found between the temperature of the bupivacaine administered and the occurrence of shivering among the participants. (Table 4)

Table 4. Association between shivering and temperature of bupivacaine.

Variable		Worm		Cold	
Shivering		Number	%	Number	%
	Yes	16	32.0	24	48.0
	No	34	68.0	26	52.0
	Total	50	100.0	50	100.0

The risk of experiencing shivering was meticulously estimated using binary logistic regression models. Both univariate and multivariate models were meticulously constructed to explore the factors influencing shivering. In the univariate analysis, it was observed that patients who received cold bupivacaine were almost twice as likely to develop shivering compared to those who received worm bupivacaine, with a 1.962 times higher odds. Interestingly, worm bupivacaine was identified as a protective factor against shivering, with an odds ratio of 0.510. Moreover, the duration of the block exhibited a protective effect against shivering, with an odds ratio of 0.66. Notably, the highest systolic blood pressure was more predictive of shivering compared to the lowest systolic blood pressure, with odds ratios of 1.049 and 0.994, respectively. Similarly, both the highest and lowest diastolic blood pressure values were significant predictors of shivering, with odds ratios of 1.021 and 1.034, respectively. Surprisingly, only the pulse rate demonstrated a statistically significant association with shivering, with the odds of developing shivering being 1.098 times higher for individuals with a higher pulse rate. Interestingly, individuals with higher oxygen saturation levels were 1.107 times more likely to experience shivering than those with lower oxygen saturation levels. In the multivariate analysis, all the variables were considered collectively to assess their combined effects on shivering. It was found that the temperature of the bupivacaine used had a statistically significant impact on predicting shivering, with a p-value of less than 0.05. The odds of developing shivering were 2.567 times higher when cold bupivacaine was administered compared to worm bupivacaine, which exhibited a protective effect against shivering with an odds ratio of 0.39.

Recent trends in obstetric anesthesia indicate a growing preference for regional anesthesia over general anesthesia due to the higher mortality rates associated with general anesthesia when compared to regional anesthesia, despite the fact that regional anesthesia also carries its own set of risks. It is important to note that fatalities related to regional anesthesia are mainly linked to excessively high regional blocks and the toxicity of local anesthetics (32). The use of heavy bupivacaine for spinal anesthesia has become increasingly common, with a prevalence of 0.5%. Our research involved a comparison of hyperbaric bupivacaine at two different temperatures, both of which can be easily achieved by storing hyperbaric bupivacaine ampules either in the operating room or in a refrigerator. Shivering is a common side effect of spinal anesthesia, and while the exact cause and the most effective prevention methods are still unknown, the reported incidence of shivering in neuraxial anesthesia is approximately 50% (33)(34). The primary factors contributing to shivering in surgical patients include intraoperative temperature loss, pain, and the direct impact of the temperature of local anesthesia on temperature-sensitive neurons in the spinal cord (35). Our study revealed that the use of hyperbaric bupivacaine at temperatures ranging from 4-6°C increased the incidence of shivering compared to the warmer group using bupivacaine at temperatures of 23-25°C. This finding aligns with the results of Najafianaraki et al., who observed lower incidences and intensities of shivering in the warmer group(36). In a

particular investigation conducted by Kishore et al, the utilization of hyperbaric bupivacaine at temperatures of 4 C°, 22 C°, and 37 C° for spinal anesthesia in parturient undergoing cesarean section revealed that altering the temperature of bupivacaine does not have a significant impact on the overall occurrence of shivering(37). Interestingly, it was observed that cooling of the medication could potentially trigger early onset of shivering among the subjects. This indicates that factors beyond just the temperature of the local anesthetic solution play a role in the induction of shivering during spinal anesthesia, suggesting a more complex interplay of variables at play. In a separate study by Ponte et al, no noticeable effects on the intensity of shivering were detected following the administration of three 80 ml injections of either warm (39.8 C° 1.2 C°) or cold (17 C° 2.2 C°) saline into the extradural space of volunteers(38). This particular outcome implies that the cooling of the extradural space alone does not lead to shivering occurrences. Therefore, the data presented strongly suggest that while the temperature of the local anesthetic solution is a factor, it is not the sole determinant in the provocation of shivering during spinal anesthesia, hinting at the existence of other contributing factors yet to be fully elucidated. The metabolic and hemodynamic implications of shivering involve the utilization of both cardiac and systemic energy resources, leading to an elevation in oxygen consumption and the production of carbon dioxide, as well as an increase in cardiac workload.

Our research demonstrates a notable rise in heart rate linked to shivering, while there were no discernible alterations in blood pressure or oxygen saturation levels. The utilization of bupivacaine at varying temperatures in our investigation did not yield any variance in the duration of the block. Interestingly, Beards worth and colleagues documented a significantly prolonged block duration with plain bupivacaine at 37 c0 (39), whereas Stlenstra and his team noted no disparity in block duration. Notably, our findings align with those of Stlenstra and colleagues, as we observed no discrepancy in block duration between heavy bupivacaine administered at 37 c0 compared to 20 c0.

4. Conclusion

Our study comparing warm and cold storage of heavy bupivacaine for spinal anesthesia in cesarean section revealed that while there was no significant difference in vital signs and duration of block between the two groups, the incidence of shivering was notably higher in patients receiving cold bupivacaine. These findings underscore the importance of considering the temperature of the local anesthetic solution in mitigating shivering, a common complication associated with spinal anesthesia. However, it is evident that factors beyond just the temperature may contribute to the induction of shivering, indicating a need for further exploration of the underlying mechanisms. Clinically, optimizing the temperature of bupivacaine solutions may help enhance patient comfort and minimize adverse events during cesarean sections. Future research could delve deeper into elucidating the multifactorial nature of shivering during spinal anesthesia and explore additional strategies for its prevention and management, ultimately improving the safety and efficacy of obstetric anesthesia practices.

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