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Correlation of Skin Temperature Variation, Cold Test, and Pinprick Test with Sensory Block Height Following Spinal Anesthesia

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KEYWORDS

spinal anesthesia;

skin temperature;

sensory block;

cold test;
pinprick test

ABSTRACT:

Introduction: Accurate evaluation of sensory block height after spinal anesthesia is essential for safe and effective anesthesia. Conventional cold and pinprick tests are subjective, prompting interest in skin temperature changes as an objective indicator of sympathetic blockade.

Materials and Methods: This prospective observational study enrolled 35 ASA II patients undergoing cesarean section under spinal anesthesia. Hyperbaric bupivacaine 0.5% (10 mg) with fentanyl 25 µg was administered intrathecally. Skin temperature was measured at dermatomes T4, T6, and T8 before anesthesia and at 1–5 minutes afterward. Sensory block was assessed using cold and pinprick tests. Diagnostic accuracy of temperature changes was evaluated using ROC analysis.

Results: Skin temperature increased significantly over time at all dermatomes ($p < 0.05$), with the greatest rise at T8, followed by T6 and T4. Cold and pinprick tests showed time-dependent associations with block height, becoming uniformly positive by minute four. Skin temperature changes demonstrated excellent diagnostic performance for predicting positive cold (AUC = 0.943) and pinprick test results (AUC = 0.944). Temperature increases of 0.35–0.45 °C yielded high sensitivity and specificity.

Conclusion: Skin temperature monitoring is a rapid, objective, and reliable method for assessing sensory block height following spinal anesthesia.

1. Introduction

Spinal anesthesia is widely used for surgical procedures below the umbilicus, particularly in obstetric, orthopedic, gynecologic, and urologic surgery, due to its simplicity, cost-effectiveness, favorable safety profile, and ability to provide adequate intraoperative anesthesia and postoperative analgesia [1]. Despite these advantages, the extent of sensory block following spinal anesthesia must be accurately assessed to ensure adequate surgical conditions and to prevent complications associated with excessively high block levels, such as hypotension, bradycardia, respiratory muscle paralysis, and altered mental status [2,3].

Assessment of sensory block height is therefore a critical component of perioperative anesthetic management and is closely associated with patient comfort, satisfaction, and surgical success [4,5]. Several patient-related and anesthetic factors, including local anesthetic baricity, dose, patient positioning, age, body mass index, and height, have been shown to influence the spread of spinal anesthesia and the risk of high spinal block [3,6].

The cold test remains the most commonly used clinical method to evaluate sensory block level. This method assesses loss of cold sensation across dermatomes bilaterally; however, it is inherently subjective, time-consuming, dependent on patient cooperation, and prone to false-positive and false-negative findings [7].

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Similarly, the pinprick test, although widely used, relies on patient perception and examiner interpretation, which may limit its reliability in certain clinical settings [8].

During spinal anesthesia, sympathetic blockade leads to peripheral vasodilation and increased regional blood flow, resulting in a measurable rise in skin temperature. Consequently, changes in skin temperature have been proposed as an objective and noninvasive indicator of block success and extent [9]. Previous studies have demonstrated that skin temperature monitoring may achieve high sensitivity and positive predictive value in detecting effective neural blockade [10]. Moreover, Khan et al. (2025) reported that skin temperature changes may outperform cold sensation testing in terms of diagnostic accuracy for block assessment [11].

Despite these findings, comparative evidence evaluating skin temperature changes alongside cold and pinprick tests for determining sensory block height after spinal anesthesia remains limited, particularly in the Indonesian clinical context. Establishing the most accurate and practical modality for block assessment may enhance intraoperative decision-making, optimize anesthetic management, and improve patient comfort and satisfaction. Therefore, this study aimed to evaluate the relationship between skin temperature changes, cold test, and pinprick test as indicators of sensory block height following spinal anesthesia in patients undergoing cesarean section.

2. Methods

Study Design and Setting

This study was a prospective observational analytic study with repeated measures, conducted at Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia. Data collection was performed after obtaining approval from the institutional ethics committee and hospital authorities and continued until the predetermined sample size was achieved.

Study Population, Sampling, and Sample Size

The study population consisted of patients undergoing cesarean section under spinal anesthesia at RSUP Dr. Wahidin Sudirohusodo Hospital. Eligible participants were recruited consecutively using a convenience sampling method during the study period. Sample size estimation was based on numerical analytic considerations, using a standard deviation of 0.3 derived from previous studies and a margin of error of 0.1, resulting in a minimum required sample size of 35 participants.

Eligibility Criteria

Inclusion criteria were patients aged ≥18 years, classified as American Society of Anesthesiologists Physical Status (ASA PS) I or II, with a body mass index (BMI) between 18 and 30 kg/m², undergoing cesarean section under spinal anesthesia. Spinal anesthesia was performed using hyperbaric bupivacaine 0.5% (10 mg) combined with fentanyl 25 µg, administered via a paramedian approach in either the sitting or left lateral decubitus position.

Exclusion criteria included incomplete medical records, peripheral vascular disease, cardiovascular disease, diabetes mellitus with autonomic neuropathy, hypertensive disorders of pregnancy, conversion to general anesthesia, or refusal to participate in the study.

Study Procedures

After obtaining written informed consent, spinal anesthesia was administered according to a standardized institutional protocol. Following intrathecal injection, patients were positioned supine with left uterine displacement. Skin temperature was measured using a handheld infrared thermometer at the mid-sternal line corresponding to dermatomes T4, T6, and T8. Baseline measurements were obtained immediately before spinal anesthesia, followed by repeated measurements at 1, 2, 3, 4, and 5 minutes after intrathecal drug administration.

Sensory block height was assessed using both cold and pinprick tests. The cold test was performed by applying ice to bare skin along the mid-axillary line at dermatomes T4–T8, while the pinprick test was conducted using a light needle stimulus along the mid-clavicular line at the same dermatomes. Sensory testing was performed at one-minute intervals for five minutes. The target sensory block level for surgery was T4, and confirmation of block height reaching T4 was performed by the attending anesthesiologist prior to surgical preparation.

Adequacy of spinal anesthesia for surgery was clinically confirmed prior to skin incision by the attending obstetrician using surgical forceps at the operative site. Absence of pain was considered indicative of an

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adequate sensory block. This assessment was performed immediately before surgical incision as a confirmation of clinical block adequacy rather than as a primary study outcome. The obstetrician was not involved in data collection of temperature measurements. To minimize confounding factors affecting skin temperature, ambient operating room temperature was maintained at a constant level, no active warming devices were applied during the first five minutes following spinal anesthesia, and all intravenous fluids were administered at room temperature.

Data Analysis

Data were analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Normality of numerical variables was assessed using the Shapiro–Wilk test. Continuous variables are presented as mean ± standard deviation (SD) or median (minimum–maximum), as appropriate.

Repeated measurements of skin temperature were analyzed using the Wilcoxon signed-rank test. Categorical variables were analyzed using the chi-square test or Fisher's exact test, while paired categorical comparisons were assessed using the McNemar test. Diagnostic performance of skin temperature changes in predicting positive cold and pinprick test results was evaluated using receiver operating characteristic (ROC) curve analysis. Statistical significance was defined as a p-value < 0.05.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Universitas Hasanuddin (No. 767/UN4.6.4.5.31/PP36/2025). All participants provided written informed consent prior to enrollment, and the study was conducted in accordance with the Declaration of Helsinki.

3. Results

Characteristics of Study Participants

A total of 35 patients who underwent surgical procedures under spinal anesthesia at RSUP Dr. Wahidin Sudirohusodo were included in this study. All study participants were female and classified as American Society of Anesthesiologists Physical Status (ASA PS) II. The baseline characteristics of the participants are summarized in Table 1.

The age of the participants ranged from 18 to 53 years. Body weight varied between 46 and 90 kg, while body mass index (BMI) ranged from 19.15 to 36.00 kg/m². Based on the observed range, several participants were classified within the obese category. Baseline skin temperature prior to spinal anesthesia ranged from 36.63°C to 37.20°C. The majority of participants had no comorbid conditions (86.6%). The remaining participants presented with comorbidities, including diabetes mellitus (8.6%) and hypertension (2.9%).

Table 1. Characteristics of the study subjects

Characteristic	n (%) / Min-Max
Age (years)	18.00-53.00
Comorbidities	
None	31 (86.6)
Diabetes mellitus	3 (8.6)
Hypertension	1 (2.9)
Body weight (kg)	46.00-90.00
BMI (kg/m²)	19.15-36.00
Baseline temperature (°C)	36.63-37.20

Changes in Skin Temperature at Different Block Levels Over Time

Skin temperature changes before and after spinal anesthesia were measured at 1, 2, 3, 4, and 5 minutes following spinal anesthesia at dermatomes T4, T6, and T8. The results of the temporal analysis of skin temperature changes at block levels T4, T6, and T8 are presented in Table 2.

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Table 2. Changes in skin temperature over time at block levels T4, T6, and T8 after spinal anesthesia administration

Time	Change in temperature (°C)					
	T4		T6		T8	
	Median (min-max)	p-value	Median (min-max)	p-value	Median (min-max)	p-value
Minute 0-1	0.20 ± 0.08	< 0.001	0.20 ± 0.07	< 0.001	0.30 ± 0.09	< 0.001
Minute 1-2	0.21 ± 0.11	< 0.001	0.21 ± 0.09	< 0.001	0.25 ± 0.11	< 0.001
Minute 2-3	0.21 ± 0.08	< 0.001	0.22 ± 0.08	< 0.001	0.18 ± 0.11	< 0.001
Minute 3-4	0.20 ± 0.09	< 0.001	0.20 ± 0.07	< 0.001	0.21 ± 0.08	< 0.001
Minute 4-5	0.22 ± 0.10	< 0.001	0.24 ± 0.10	< 0.001	0.23 ± 0.12	< 0.001
Minute 0-2	0.40 ± 0.12	< 0.001	0.40 ± 0.11	< 0.001	0.50 ± 0.18	< 0.001
Minute 0-3	0.60 ± 0.12	< 0.001	0.60 ± 0.12	< 0.001	0.70 ± 0.14	< 0.001
Minute 0-4	0.80 ± 0.14	< 0.001	0.80 ± 0.14	< 0.001	0.90 ± 0.15	< 0.001
Minute 0-5	1.00 ± 0.17	< 0.001	1.10 ± 0.17	< 0.001	1.20 ± 0.18	< 0.001

Wilcoxon test

As shown in Table 2, skin temperature increased significantly at all measured time points (1–5 minutes) after spinal anesthesia at dermatomes T4, T6, and T8 compared with baseline values and between successive time points ($p < 0.05$). The magnitude of skin temperature elevation progressively increased with longer durations following spinal anesthesia across all assessed dermatomes. Figure 1 shows that the greatest increase in skin temperature occurred at the T8 dermatome, followed by T6, while the smallest increase was observed at the T4 dermatome.

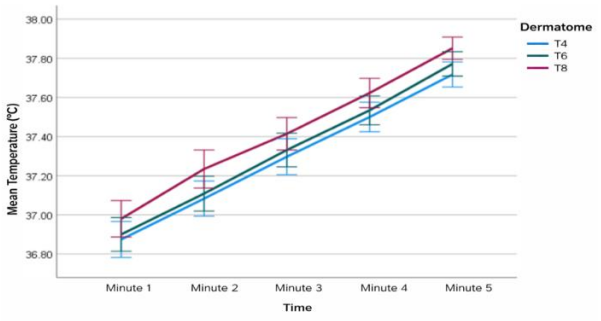

Figure 1. Changes in temperature according to block height over time

Cold Test Results Over Time at Block Levels T4, T6, and T8 Following Spinal Anesthesia

Cold test results were assessed at 1, 2, 3, 4, and 5 minutes following spinal anesthesia at dermatomes T4, T6, and T8. The temporal analysis of cold test outcomes at block levels T4, T6, and T8 after spinal anesthesia is presented in Table 3. As shown in Table 3, significant differences in cold test results were observed between minute 1 and minute 2 following spinal anesthesia at dermatomes T4, T6, and T8 ($p < 0.05$). Between minute 2 and minute 3, a significant difference in cold test results was observed at the T4 dermatome ($p < 0.05$), whereas no significant difference was found at the T6 dermatome ($p > 0.05$). A comparison of cold test results according to block level and time of assessment is illustrated in Figure 2.

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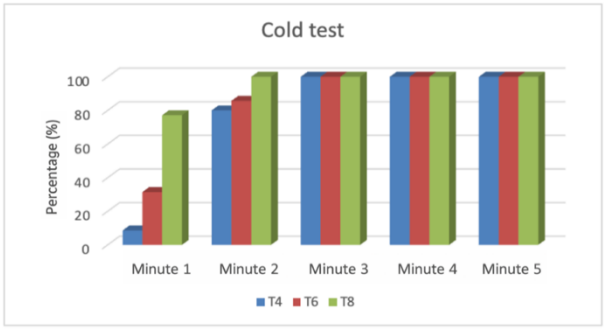

Figure 2. Comparison of cold test results according to block level and measurement time

Figure 2 demonstrates that at 1 and 2 minutes after spinal anesthesia, the highest proportion of patients with positive cold test results was observed at the T8 dermatome, followed by T6, while the lowest proportion was observed at T4. At 3, 4, and 5 minutes after spinal anesthesia, all patients demonstrated positive cold test results at dermatomes T4, T6, and T8. These findings indicate that differences in cold test results were associated with block height during the first 1–2 minutes following spinal anesthesia, whereas the cold test reliably indicated successful anesthesia at T4, T6, and T8 from 3 to 5 minutes after spinal anesthesia.

Table 3. Cold test results over time at block levels T4, T6, and T8 after spinal anesthesia administration

Time	Cold test					
	T4		T6		T8	
	Positive	Negative	Positive	Negative	Positive	Negative
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Minute 1	3 (8.57)	32 (91.43)	11 (31.43)	24 (68.57)	27 (77.14)	8 (22.86)
Minute 2	28 (80.00)	7 (20.00)	30 (85.71)	5 (14.29)	35 (100.00)	0 (0)
Minute 3	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)
Minute 4	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)
Minute 5	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)
P-value[a]	< 0.001		< 0.001		0.008	
P-value[b]	0.016		0.063		-	
P-value[c]	-		-		-	
P-value[d]	-		-		-	

[a]McNemar test at Minute 1–Minute 2, [b]McNemar test at Minute 2–Minute 3, [c]McNemar test at Minute 3–Minute 4, [d]McNemar test at Minute 4–Minute 5

Pinprick Test Results Over Time at Block Levels T4, T6, and T8 Following Spinal Anesthesia

Pinprick test results were assessed at 1, 2, 3, 4, and 5 minutes following spinal anesthesia at dermatomes T4, T6, and T8. Temporal changes in pinprick test outcomes at different block levels are presented in Table 4. As shown in Table 4, significant differences in pinprick test results were observed between minute 1 and minute 2 and between minute 2 and minute 3 at dermatomes T4, T6, and T8 ($p < 0.05$). Between minute 3 and minute 4, a significant difference was observed at the T4 dermatome ($p < 0.05$), whereas no significant differences were found at dermatomes T6 and T8 ($p > 0.05$). A comparison of pinprick test results by block level and time point is illustrated in Figure 3.

Table 4. Pinprick test results over time at block levels T4, T6, and T8 after spinal anesthesia administration

Time	Pinprick test					
	T4		T6		T8	
	Positive	Negative	Positive	Negative	Positive	Negative
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)

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Minute 1	0 (0.00)	35 (100.00)	3 (8.57)	32 (91.43)	12 (34.29)	23 (65.71)
Minute 2	14(40.00)	21 (60.00)	17 (48.57)	18 (51.43)	28 (80.00)	7 (20.00)
Minute 3	28 (80.00)	7 (20.00)	31 (88.57)	4 (11.43)	34 (97.14)	1 (2.86)
Minute 4	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)
Minute 5	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)
P-value[a]	< 0.001		< 0.001		< 0.001	
P-value[b]	< 0.001		< 0.001		0.031	
P-value[c]	0.016		0.125		1.000	
P-value[d]	-		-		-	

[a]McNemar test at Minute 1–Minute 2, [b]McNemar test at Minute 2–Minute 3, [c]McNemar test at Minute 3–Minute 4, [d]McNemar test at Minute 4–Minute 5

At 1, 2, and 3 minutes after spinal anesthesia, the highest proportion of patients with positive pinprick test results was observed at the T8 dermatome, followed by T6, with the lowest proportion at T4. At 4 and 5 minutes after spinal anesthesia, all patients demonstrated positive pinprick test results at dermatomes T4, T6, and T8. Additionally, as shown in Table 5, all patients exhibited positive results on both cold and pinprick tests at 4 minutes following spinal anesthesia at dermatomes T4, T6, and T8. At this time point, skin temperature increased significantly from baseline, with mean increases of 0.8 °C at T4, 0.8 °C at T6, and 0.9 °C at T8.

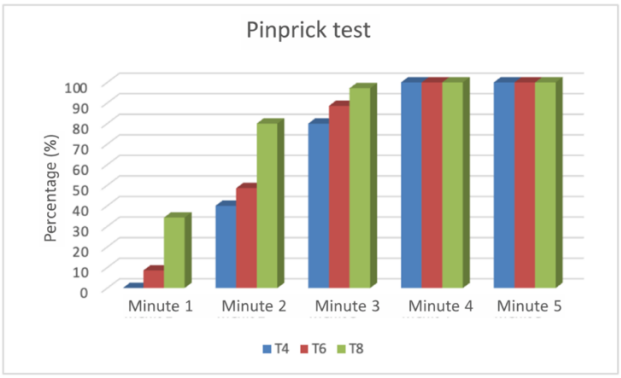

Figure 3. Comparison of pinprick test results according to block level and measurement time

Diagnostic Performance of Skin Temperature Changes in Predicting Cold and Pinprick Test Results

The diagnostic performance of skin temperature changes in predicting cold test outcomes following spinal anesthesia was evaluated using area under the receiver operating characteristic curve (AUC) analysis. As shown in Figure 4, the AUC for skin temperature change in predicting positive cold test results was 0.943 ($p < 0.001$; 95% CI, 0.924–0.963). Across all dermatomes and time points (1–5 minutes) compared with baseline, a temperature increase cut-off value of 0.35 °C was identified, yielding a sensitivity of 88% and a specificity of 82.9% for predicting positive cold test results at all assessed block levels. Similarly, the diagnostic performance of skin temperature changes in predicting pinprick test outcomes is presented in Figure 5. The AUC for predicting positive pinprick test results was 0.944 ($p < 0.001$; 95% CI, 0.926–0.962). A temperature increase cut-off value of 0.45 °C across all dermatomes and time points demonstrated a sensitivity of 89.7% and a specificity of 85.1% for predicting positive pinprick test results.

Table 5. Summary of changes in temperature, cold test, and pinprick test results over time at different block levels after spinal anesthesia

Dermatome	Time	Change in temperature (°C)	Cold Test		Pinprick test	
			Positive	Negative	Positive	Negative
T4	Minute 1	0.20 ± 0,08	3 (8.57)	32 (91.43)	0 (0.00)	35 (100.00)
	Minute 2	0.40 ± 0.12	28 (80.00)	7 (20.00)	14(40.00)	21 (60.00)

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	Minute 3	0.60 ± 0.12	35 (100)	0 (0)	28 (80.00)	7 (20.00)
	Minute 4	**0.80 ± 0.14**	**35 (100)**	**0 (0)**	**35 (100)**	**0 (0)**
	Minute 5	1.00 ± 0.17	35 (100)	0 (0)	35 (100)	0 (0)
T6	Minute 1	0.20 ± 0.07	11 (31.43)	24 (68.57)	3 (8.57)	32 (91.43)
	Minute 2	0.40 ± 0.11	30 (85.71)	5 (14.29)	17 (48.57)	18 (51.43)
	Minute 3	0.60 ± 0.12	35 (100)	0 (0)	31 (88.57)	4 (11.43)
	Minute 4	**0.80 ± 0.14**	**35 (100)**	**0 (0)**	**35 (100)**	**0 (0)**
	Minute 5	1.10 ± 0.17	35 (100)	0 (0)	35 (100)	0 (0)
T8	Minute 1	0.30 ± 0.09	27 (77.14)	8 (22.86)	12 (34.29)	23 (65.71)
	Minute 2	0.50 ± 0.18	35 (100)	0 (0)	28 (80.00)	7 (20.00)
	Minute 3	0.70 ± 0.14	35 (100)	0 (0)	34 (97.14)	1 (2.86)
	Minute 4	**0.90 ± 0.15**	**35 (100)**	**0 (0)**	**35 (100)**	**0 (0)**
	Minute 5	1.20 ± 0.18	35 (100)	0 (0)	35 (100)	0 (0)

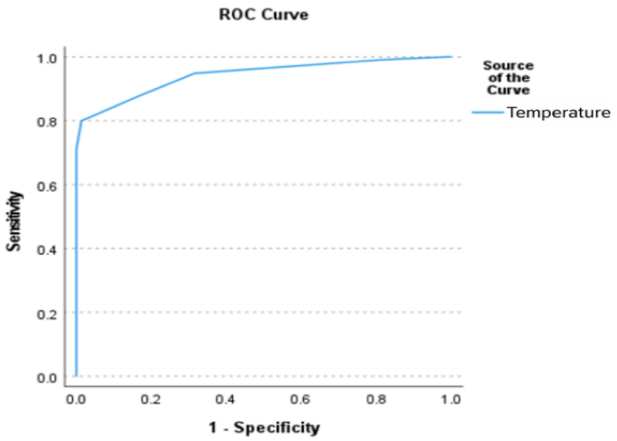

Figure 4. AUC curves of temperature changes and cold test results across all block levels

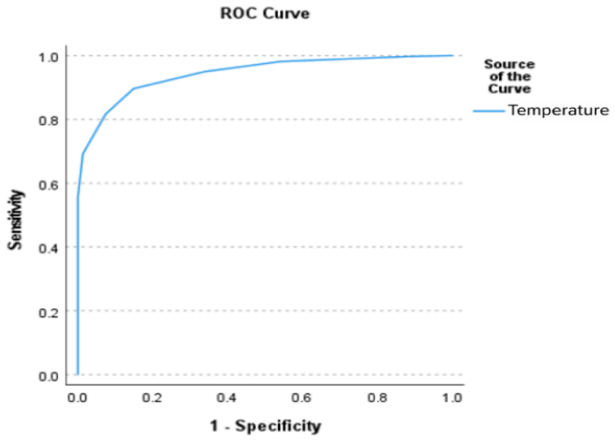

Figure 5. AUC curves of temperature changes and pinprick test results across all block levels

4. Discussion

This study included 35 female patients with ASA Physical Status II undergoing cesarean section under spinal anesthesia. The participants were aged between 18 and 53 years, representing a young to middle-aged population. Body weight ranged from 46 to 90 kg, and BMI varied between 19.15 and 36.00 kg/m², indicating a spectrum from normal weight to obesity. Baseline temperature prior to spinal anesthesia ranged from 36.63°C to 37.20°C, reflecting normothermic conditions across participants. Most subjects had no comorbidities (86.6%), while a small proportion had diabetes mellitus (8.6%) or hypertension (2.9%), suggesting a predominantly healthy study population. Adjustment of spinal anesthetic dosing based on patient anthropometry has been shown to improve anesthetic safety and reduce maternal hypotension and vasopressor requirements [12] . Previous evidence indicates that body mass index is associated with the spread and height of spinal sensory block, particularly in obstetric patients [13]. Despite the increased anesthetic risk associated with obesity, spinal anesthesia remains preferable to general anesthesia due to lower risks of airway complications, aspiration, and

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postoperative respiratory impairment [14]. Although a minority of patients in this study had comorbidities such as diabetes mellitus and hypertension, spinal anesthesia has been reported to be safe in such populations and may offer additional benefits, including opioid-sparing analgesia and faster postoperative recovery [14,15]. Age-related alterations in sympathetic tone and vascular responsiveness may also influence thermoregulatory responses during neuraxial anesthesia [16].

The present findings demonstrate a significant and progressive increase in skin temperature from 1 to 5 minutes following spinal anesthesia at dermatomes T4, T6, and T8. The magnitude of temperature elevation ranged from approximately 0.2–0.3 °C at 1 minute to 1.0–1.2 °C at 5 minutes compared with baseline. These results are consistent with previous studies showing that spinal anesthesia induces sympathetic blockade, resulting in peripheral vasodilation, increased regional blood flow, and measurable increases in skin temperature [17,18]. Early temperature changes observed in this study align with reports indicating that skin warming can occur within seconds to minutes after intrathecal injection, reflecting rapid onset of sympathetic block [16]. Similar sustained increases in skin temperature following spinal anesthesia have also been described in recent studies involving obstetric populations [19,20].

Notably, the magnitude of temperature increase differed according to block height, with the greatest increase observed at the T8 dermatome, followed by T6 and T4. This pattern likely reflects more complete sympathetic blockade in lower thoracic dermatomes, where inhibition of tonic vasoconstriction leads to greater increases in skin perfusion and surface temperature [17]. These findings support the concept that skin temperature monitoring may serve as an objective surrogate marker of sympathetic block during neuraxial anesthesia.

Cold test results in this study were associated with block height during the first 1–2 minutes after spinal anesthesia but became uniformly positive across all assessed dermatomes by 3–5 minutes. This suggests that cold testing is useful for early differentiation of block height but loses discriminatory value once sensory block is fully established. Previous studies have reported similar findings, with cold sensation often indicating higher dermatomal levels earlier than pinprick testing [21,22]. The earlier positivity of cold testing compared with pinprick testing observed in this study is consistent with differential blockade of sensory fibers, as cold sensation is primarily mediated by C fibers, whereas pinprick sensation involves Aβ fibers [23].

Pinprick testing in this study showed a significant association with block height during the first 3 minutes after spinal anesthesia and became uniformly positive at 4–5 minutes. This temporal pattern aligns with previous reports indicating a slower onset of pinprick block compared with cold sensation [24,25]. Although a sensory level of T4 is traditionally considered optimal for cesarean delivery, several studies have suggested that lower block levels, such as T6–T8, may still provide clinically adequate analgesia when supplemented appropriately after fetal delivery [26].

Importantly, the diagnostic analysis demonstrated that increases in skin temperature of approximately 0.8 °C at T4 and T6 and 0.9 °C at T8 reliably predicted positive cold and pinprick test results, with high sensitivity and specificity. These findings indicate that skin temperature monitoring offers an objective, rapid, and noninvasive method for assessing block success and extent, potentially reducing reliance on subjective sensory testing. Environmental factors that may influence skin temperature measurements were controlled in this study, including ambient operating room temperature and perioperative fluid administration, which is critical given that small temperature differences can affect interpretation [20,27].

Overall, this study supports the use of skin temperature changes as a practical and cost-effective adjunct or alternative to conventional sensory tests for assessing the success and level of spinal anesthesia. As one of the first studies to evaluate the combined relationship between skin temperature changes, cold testing, and pinprick testing in estimating spinal block height, these findings provide a basis for further investigation. Nevertheless, the single-center design and limited sample size warrant cautious interpretation, and larger multicenter studies are needed to confirm the generalizability of these results.

5. Conclusions

This study demonstrated a progressive and significant increase in skin temperature over time at dermatomes T4, T6, and T8 following spinal anesthesia. The magnitude of temperature change increased steadily from the first to

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the fifth minute, with the greatest increase consistently observed at the T8 dermatome, followed by T6 and T4. These findings indicate that skin temperature changes occur rapidly after intrathecal injection and vary according to block height, reflecting the extent of sympathetic blockade induced by spinal anesthesia.

In addition, both cold and pinprick test results showed time-dependent associations with block height, with earlier positivity observed at lower thoracic dermatomes. By the fourth minute after spinal anesthesia, all patients demonstrated positive cold and pinprick test results at T4, T6, and T8. Importantly, increases in skin temperature of approximately 0.8 °C at T4 and T6 and 0.9 °C at T8 at four minutes after spinal anesthesia were significantly associated with positive cold and pinprick test outcomes. These results suggest that skin temperature monitoring may serve as an objective, noninvasive, and practical indicator of sensory block success and extent following spinal anesthesia.

6. Declarations

Consent for Publication

Consent for publication was not required because the manuscript does not contain identifiable personal information or images of individual participants.

Authors' Contributions

ARH conducted the study, collected and analyzed the data, and drafted the manuscript. AMTM and MD were involved in study design, data analysis, manuscript editing, and overall research supervision. SG, NSW, and RBS contributed to data interpretation and provided critical revisions of the manuscript. All authors participated in manuscript revision and approved the final version.

Data Availability

The data supporting the findings of this study are included within the manuscript.

Conflict of Interest

The authors report no conflicts of interest associated with this study.

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