

**Intrathecal versus Intravenous Fentanyl for Intraoperative Shivering: A Prospective Randomized Controlled Trial****Kiran B. Patel<sup>1</sup>, R.T. Sathish Kumar<sup>2</sup>, Pamuri Prathap Reddy<sup>3</sup>, Jigar Bhavsar<sup>4</sup>, Diptiben Kantibhai Chaudhary<sup>5</sup>**<sup>1</sup>Associate Professor, Department of Anaesthesiology, B.J. Medical College and Civil Hospital, Ahmedabad, Gujarat, India<sup>2</sup>Senior Resident, Department of Anaesthesiology, B.J. Medical College and Civil Hospital, Ahmedabad, Gujarat, India<sup>3</sup>Third year Resident, Department of Anaesthesiology, B.J. Medical College and Civil Hospital, Ahmedabad, Gujarat, India<sup>4</sup>Assistant Professor, Department Of Anaesthesiology, ESIC Medical College, Bapunagar, Ahmedabad<sup>5</sup>Second year Resident, Department of Anaesthesiology, B.J. Medical College and Civil Hospital, Ahmedabad, Gujarat, India

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Conflict of interest: Nil

**Abstract****Background:** Intraoperative shivering is a common complication during spinal anaesthesia, leading to patient discomfort and potential hemodynamic alterations. Fentanyl, administered via different routes, has been used to prevent shivering, but comparative efficacy of intrathecal versus intravenous administration remains unclear. This study aimed to evaluate and compare the effectiveness of intrathecal and intravenous fentanyl for intraoperative shivering.**Material and Methods:** A prospective randomized controlled study was conducted at BJMC and Civil Hospital, Ahmedabad, from August 2024 to March 2025. A total of 120 patients, aged 18–60 years, ASA I–II, scheduled for elective surgeries under spinal anaesthesia, were randomly assigned to two groups: Group A received intrathecal fentanyl 25 µg (n=60) and Group B received intravenous fentanyl 1 µg/kg (n=60). Shivering scores and sedation levels (Ramsay Sedation Scale) were recorded at 5-minute intervals intraoperatively. Baseline demographic and clinical characteristics, including age, gender, height, weight, BMI, and ASA status, were comparable between groups. Statistical analysis was performed using Student's t-test and Chi-square test, with  $p < 0.05$  considered significant.**Results:** Baseline characteristics were similar between groups ( $p > 0.05$ ). Shivering scores were significantly lower in Group A compared to Group B from 5 minutes onwards (e.g., 5 min:  $0.72 \pm 0.52$  vs  $1.02 \pm 0.75$ ,  $p = 0.012$ ), with differences remaining significant throughout the surgery. Sedation scores increased gradually in both groups; Group B exhibited slightly higher scores at most time points, with statistically significant differences at several intervals (e.g., 20 min:  $2.02 \pm 0.29$  vs  $2.20 \pm 0.48$ ,  $p = 0.013$ ). No adverse hemodynamic effects were observed.**Conclusion:** Intrathecal fentanyl is more effective than intravenous fentanyl in preventing intraoperative shivering while providing adequate sedation without compromising hemodynamic stability. Intrathecal administration can be considered a safe and superior approach for shivering management during spinal anaesthesia.**Keywords:** Intrathecal Fentanyl, Intravenous Fentanyl, Intraoperative Shivering, Spinal Anaesthesia, Ramsay Sedation Scale.

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**Introduction**

Intraoperative shivering is a frequent and distressing complication associated with spinal anaesthesia, with reported incidence rates as high as 40–70% in patients undergoing various surgical procedures under neuraxial blockade. Shivering not only causes discomfort but also increases metabolic

demand, oxygen consumption, carbon dioxide production, and can interfere with routine monitoring such as electrocardiography and pulse oximetry, potentially exacerbating perioperative risk, especially in patients with limited cardiopulmonary reserve [1–3]. The

pathophysiology of shivering under spinal anaesthesia is multifactorial, involving core-peripheral temperature redistribution due to sympathetic blockade and altered thermoregulatory thresholds at the spinal cord level [4].

Various pharmacologic agents have been evaluated for preventing or mitigating intraoperative shivering, including opioids and non-opioid agents administered via systemic or neuraxial routes. Lipophilic opioids, particularly fentanyl, when added intrathecally to local anaesthetics, have been shown to reduce both the incidence and severity of shivering by modulating thermo-regulatory pathways and enhancing the quality of spinal anaesthesia without substantially prolonging motor blockade [5,6]. Clinical trials and systematic analyses suggest that intrathecal fentanyl significantly decreases shivering compared to control or plain local anaesthetic groups, often with a favourable side-effect profile at lower doses [5,6]. Intravenous administration of fentanyl has also demonstrated antishivering effects, although the comparative efficacy between intrathecal and intravenous routes remains inadequately defined, with limited direct evidence addressing this specific question.

Given the ongoing need to optimize shivering prophylaxis in patients receiving spinal anaesthesia for elective surgeries, evaluating the relative effectiveness of intrathecal versus intravenous fentanyl is clinically relevant. This study was undertaken to compare these two approaches in terms of their impact on intraoperative shivering and associated sedation profiles.

## Material and Methods

**Study design and setting:** This prospective, randomized, comparative study was conducted to evaluate the efficacy of intrathecal fentanyl versus intravenous fentanyl in preventing intraoperative shivering in patients undergoing elective surgeries under spinal anaesthesia. The study was carried out at BJMC and Civil Hospital, Ahmedabad, between August 2024 and March 2025. Ethical approval was obtained from the institutional ethics committee, and written informed consent was obtained from all participants.

**Study Population:** A total of 120 patients, aged 18–60 years, with American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective surgeries under spinal anaesthesia, were included. Patients were excluded if they declined participation, had a history of adverse drug reactions to study medications, contraindications to spinal anaesthesia, severe hemodynamic instability, significant comorbidities, or if the estimated duration of surgery exceeded 90 minutes.

**Sample Size:** The sample size was calculated using the formula:

$$N = (Z\alpha/2 + Z\beta)^2 \cdot [p_1(1-p_1) + p_2(1-p_2)] / (p_1 - p_2)^2$$

Where N is the sample size per group,  $p_1$ ,  $p_2$  and  $p_1 - p_2$  are the expected proportions of shivering in the respective groups,  $Z\alpha/2 = 1.96$ ,  $Z\beta = 0.84$  for  $\alpha = 0.05$ , and  $\beta = 0.8$ . Based on this calculation, 60 patients were allocated to each group.

**Randomization and Group Allocation:** Patients were randomly assigned to one of two groups using a coin toss method. The first patient and every subsequent odd-numbered patient were assigned according to the coin toss result (heads = Group A, tails = Group B), while the next even-numbered patient was allocated to the opposite group.

- **Group A (n = 60):** Intrathecal fentanyl 25 µg
- **Group B (n = 60):** Intravenous fentanyl 1 µg/kg

**Study Procedure:** Preoperatively, patients underwent a thorough assessment including verification of nil per oral (NPO) status, baseline vitals, and securing an 18G or 20G intravenous line. In the operating room, standard monitors including pulse oximetry, electrocardiogram (ECG), noninvasive blood pressure (NIBP), and respiratory rate were applied. Baseline heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), mean arterial pressure (MAP), SpO<sub>2</sub>, and respiratory rate were recorded. All patients were preloaded with 500 mL of crystalloid solution and received intravenous ondansetron 0.15 mg/kg as premedication.

Under strict aseptic conditions, spinal anaesthesia was performed at the L3–L4 interspace in the sitting or lateral decubitus position using a 23G Quincke spinal needle. Hyperbaric 0.5% bupivacaine was administered according to body weight, followed by the allocated study drug. Supplemental oxygen was provided via face mask throughout the surgery.

Patients were monitored continuously intraoperatively and for 24 hours postoperatively. Heart rate, blood pressure, and oxygen saturation were recorded every 5 minutes. Shivering and sedation scores were assessed at 5-minute intervals.

## Outcome Measures

**Shivering Assessment:** Shivering severity was graded on a 0–4 scale:

- 0: No shivering
- 1: Piloerection or peripheral vasoconstriction without visible shivering
- 2: Muscular activity involving only one muscle group

- 3: Muscular activity involving more than one muscle group, not generalized
- 4: Shivering involving the whole body

**Sedation Assessment:** Sedation was evaluated using the Ramsay Sedation Scale (1–6):

- 1: Anxious, agitated, or restless
- 2: Cooperative, oriented, and tranquil
- 3: Responds to commands only
- 4: Brisk response to light glabellar tap or loud auditory stimulus
- 5: Sluggish response to light glabellar tap or loud auditory stimulus
- 6: No response

**Statistical Analysis:** Data were recorded and analyzed using Student's t-test. Continuous variables were expressed as mean  $\pm$  standard deviation (SD). A p-value  $<0.05$  was considered statistically significant.

### Results

A total of 120 patients were enrolled and evenly randomized into two groups of 60 each. Baseline demographic and clinical characteristics were comparable between the two groups. The mean age was  $42.31 \pm 10.27$  years in Group A and  $40.32 \pm 9.81$  years in Group B ( $p = 0.282$ ). Gender distribution, height, weight, body mass index

(BMI), and ASA physical status were also similar between groups, with no statistically significant differences observed ( $p > 0.05$  for all parameters) (Table 1). Intraoperative shivering was assessed at 5-minute intervals. At baseline, no shivering was observed in either group. The incidence and severity of shivering were significantly lower in the intrathecal fentanyl group (Group A) compared to the intravenous fentanyl group (Group B) at all measured time points from 5 minutes onwards. The mean shivering scores were consistently lower in Group A, with statistically significant differences observed at 5 minutes ( $0.72 \pm 0.52$  vs  $1.02 \pm 0.75$ ,  $p = 0.012$ ), 10 minutes ( $1.03 \pm 0.84$  vs  $1.37 \pm 0.61$ ,  $p = 0.014$ ), and continuing throughout the 90-minute observation period ( $p < 0.05$  for all) (Table 2). Sedation levels, assessed using the Ramsay Sedation Scale, demonstrated a trend of mild to moderate sedation in both groups. At baseline, Group B had slightly higher sedation scores ( $1.80 \pm 0.40$ ) compared to Group A ( $1.42 \pm 0.50$ ,  $p < 0.001$ ). During the intraoperative period, sedation scores increased gradually in both groups, with Group B consistently showing slightly higher scores than Group A at most time points, reaching statistical significance at several intervals, including 20 minutes ( $2.20 \pm 0.48$  vs  $2.02 \pm 0.29$ ,  $p = 0.013$ ) and 40 minutes ( $2.65 \pm 0.52$  vs  $2.42 \pm 0.53$ ,  $p = 0.016$ ) (Table 3).

**Table 1: Baseline profile of study participants**

Parameter	Group A (n=60)	Group B (n=60)	p value
<b>Age (years)</b>			
18–30	8 (13.33%)	9 (15.00%)	0.569
31–40	19 (31.67%)	22 (36.67%)	
41–50	19 (31.67%)	21 (35.00%)	
51–60	14 (23.33%)	8 (13.33%)	
<b>Mean Age (years)</b>	$42.31 \pm 10.27$	$40.32 \pm 9.81$	0.282
<b>Gender</b>			
Male	37 (61.67%)	34 (56.67%)	0.577
Female	23 (38.33%)	26 (43.33%)	
<b>Height (cm)</b>	$159.73 \pm 7.08$	$160.30 \pm 7.44$	0.670
<b>Weight (kg)</b>	$64.07 \pm 7.89$	$62.00 \pm 7.58$	0.146
<b>BMI (kg/m<sup>2</sup>)</b>	$25.20 \pm 3.42$	$24.15 \pm 2.81$	0.069
<b>ASA Status</b>			
ASA I	22 (36.67%)	25 (41.67%)	0.575
ASA II	38 (63.33%)	35 (58.33%)	

**Table 2: Shivering Grade**

Time Interval	Group-A		Group-B		p value
	Mean	±S.D.	Mean	±S.D.	
Baseline	0.00	0.00	0.00	0.00	–
5 minute	0.72	0.52	1.02	0.75	0.012
10 minute	1.03	0.84	1.37	0.61	0.014
15 minute	1.17	1.22	1.63	1.01	0.024
20 minute	1.12	1.19	1.50	0.83	0.044
25 minute	0.98	1.19	1.37	0.71	0.034
30 minute	0.77	1.05	1.13	0.62	0.022
35 minute	0.82	1.08	1.18	0.65	0.026
40 minute	0.75	1.04	1.10	0.66	0.029
45 minute	0.73	1.04	1.13	0.68	0.014
50 minute	0.67	1.04	1.05	0.59	0.014
55 minute	0.67	1.04	1.05	0.65	0.017
60 minute	0.60	0.98	1.02	0.83	0.013
70 minute	0.50	0.85	0.90	0.88	0.013
80 minute	0.43	0.81	0.80	0.86	0.018
90 minute	0.45	0.81	0.80	0.66	0.011

\*Student's t Test; The p-value is significant at 5% level of significance

**Table 3: Sedation Score (Ramsay Sedation Scale)**

Time Interval	Group-A		Group-B		p value
	Mean	±S.D.	Mean	±S.D.	
Baseline	1.42	0.50	1.80	0.40	0.000
5 minute	1.38	0.49	1.58	0.50	0.028
10 minute	1.47	0.50	1.67	0.51	0.033
15 minute	1.87	0.34	1.68	0.50	0.022
20 minute	2.02	0.29	2.20	0.48	0.013
25 minute	2.10	0.35	2.28	0.56	0.033
30 minute	2.22	0.45	2.42	0.56	0.034
35 minute	2.33	0.51	2.57	0.59	0.023
40 minute	2.42	0.53	2.65	0.52	0.016
45 minute	2.42	0.50	2.62	0.49	0.028
50 minute	1.87	0.34	2.07	0.61	0.028
55 minute	2.00	0.00	2.12	0.42	0.032
60 minute	1.88	0.32	2.07	0.58	0.034
70 minute	1.95	0.22	2.07	0.31	0.019
80 minute	1.93	0.25	2.05	0.34	0.035
90 minute	2.00	0.00	2.12	0.37	0.017

\*Student's t Test; The p-value is significant at 5% level of significance

## Discussion

In this prospective randomized study comparing intrathecal fentanyl and intravenous fentanyl for prevention of intraoperative shivering under spinal anaesthesia, our findings demonstrate that intrathecal fentanyl resulted in significantly lower shivering scores throughout the intraoperative period compared to intravenous administration. This observation aligns with prior evidence indicating that intrathecal administration of fentanyl effectively reduces the incidence and severity of shivering associated with spinal anaesthesia [7,8]. The mechanism by which intrathecal opioids reduce shivering is thought to involve modulation of spinal thermoregulatory pathways, lowering the shivering threshold

centrally rather than solely acting on peripheral temperature changes [9,10].

Previous randomized clinical studies have shown that small doses of intrathecal fentanyl (e.g., 12.5–25 µg) significantly decrease shivering compared to local anaesthetic alone, without increasing adverse effects such as pruritus, nausea, or respiratory depression [11,12]. Intrathecal fentanyl's lipophilicity allows rapid diffusion into spinal opioid receptors, influencing afferent thermo-regulatory signals and enhancing analgesia and patient comfort [13]. This pharmacodynamic profile may partly explain the consistent reduction in shivering intensity seen in the intrathecal group in our study.

While systemic opioids such as intravenous fentanyl provide anti-shivering effects through central  $\mu$ -receptor agonism, their efficacy may be relatively less pronounced in the context of spinal anaesthesia because of slower onset, broader systemic distribution, and potential for sedation without targeted spinal modulation of shivering reflexes [14]. Similar studies comparing other routes of opioid administration have also suggested that when delivered intrathecally, opioids achieve more effective modulation of intraoperative complications like shivering than when administered systemically [15].

In addition to shivering outcomes, sedation scores in our study were higher in the intravenous group at most time points, which may reflect greater systemic opioid effect. However, both routes provided clinically acceptable sedation levels. Importantly, haemodynamic stability was maintained in both groups, echoing earlier research demonstrating that low-dose intrathecal opioids do not significantly compromise cardiovascular parameters during spinal anaesthesia [16].

A key strength of this study is its prospective randomized design with frequent objective monitoring of shivering and sedation. However, the study was single-center and limited to elective surgeries with a relatively narrow patient demographic (ASA I–II), which may limit broader generalizability. Future multicenter studies with larger cohorts could further confirm these results.

### Conclusion

Intrathecal fentanyl is more effective than intravenous fentanyl in reducing the incidence and severity of intraoperative shivering in patients undergoing elective surgeries under spinal anaesthesia. Both routes provided adequate sedation, with values remaining within clinically acceptable limits. Intrathecal administration offers the advantage of better shivering control without compromising hemodynamic stability, making it a safe and effective option for intraoperative shivering management.

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