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Original Research Article

COMPARATIVE STUDY OF THE EFFECT OF DEXMEDETOMIDINE AND BUTORPHANOL ON POST- SPINAL ANAESTHESIA SHIVERING

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ABSTRACT

Background: Post-spinal anaesthesia shivering is a common complication associated with neuraxial anaesthesia and may lead to increased metabolic demand, patient discomfort and hemodynamic instability. Various pharmacological agents have been used to control shivering, among which Dexmedetomidine and Butorphanol have gained attention due to their central anti-shivering properties. **Aim:** To evaluate and compare the efficacy of intravenous Dexmedetomidine and Butorphanol for control of shivering after spinal anaesthesia. **Material and Methods:** This prospective randomized double-blind study included 60 patients undergoing lower abdominal and lower limb surgeries under spinal anaesthesia. Patients who developed Grade II–IV shivering were randomly allocated into two groups. Group D received intravenous Dexmedetomidine 0.5 µg/kg and Group B received intravenous Butorphanol 0.01 mg/kg diluted in normal saline administered over 10 minutes. Hemodynamic parameters, time taken for cessation of shivering, recurrence of shivering, sedation score and adverse effects were recorded and analysed statistically. **Results:** Baseline demographic characteristics and duration of surgery were comparable between the groups. Mean axillary temperature showed a similar decline in both groups at the onset of shivering. Pulse rate decreased significantly in the Dexmedetomidine group at 5, 10, 15 and 30 minutes compared with the Butorphanol group ($p < 0.05$). Dexmedetomidine demonstrated better control of shivering with improved sedation profile and acceptable hemodynamic stability. **Conclusion:** Dexmedetomidine was found to be more effective than Butorphanol for control of post-spinal anaesthesia shivering with better hemodynamic modulation and adequate sedation.

INTRODUCTION

Spinal anaesthesia is widely used for lower abdominal, obstetric and lower limb surgeries because of its rapid onset, effective sensory and motor blockade, minimal airway manipulation and reduced systemic drug exposure compared with general anaesthesia. Despite these advantages, spinal anaesthesia is frequently associated with perioperative complications, among which post-anaesthetic shivering remains one of the most common and distressing adverse events encountered in the perioperative period. The incidence of shivering during neuraxial anaesthesia has been reported to range from 40% to 70%, depending on the type of surgery, ambient operating room temperature and individual patient characteristics.[1]

Shivering is defined as involuntary rhythmic muscular activity that occurs as a thermoregulatory response to hypothermia. During anaesthesia, thermoregulatory mechanisms become impaired due to the combined effects of anaesthetic drugs, redistribution of body heat, and environmental factors within the operating theatre. Spinal anaesthesia produces sympathetic blockade leading to peripheral vasodilatation, which facilitates redistribution of heat from the core compartment to the peripheral tissues. As a result, core body

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temperature decreases and the threshold for vasoconstriction and shivering is lowered.[2] Additional factors such as administration of cold intravenous fluids, exposure of body surfaces during surgery, and low ambient temperature in operating rooms further contribute to perioperative hypothermia and subsequent shivering.[3]

Although shivering is a protective thermoregulatory response, it may have significant physiological consequences in surgical patients. The most important clinical effect is a marked increase in metabolic activity, resulting in a two- to three-fold rise in oxygen consumption and carbon dioxide production. This increased metabolic demand may lead to lactic acidosis, hypoxemia and increased cardiac workload, particularly in patients with limited cardiopulmonary reserve.[4] Shivering can also cause increased intracranial and intraocular pressure, interfere with electrocardiography and blood pressure monitoring, and lead to patient discomfort and delayed postoperative recovery.[5] Furthermore, intense muscular activity associated with shivering may exacerbate postoperative pain, disrupt surgical wound healing and prolong the stay in the post-anaesthesia care unit.[6]

Various strategies have been developed to prevent and treat perioperative shivering. Non-pharmacological approaches include active warming techniques such as forced-air warming blankets, warming mattresses and warmed intravenous fluids. Although these methods help reduce heat loss, they may not always completely prevent shivering once it occurs.[7] Consequently, pharmacological agents are commonly used for its treatment. Several drugs including Tramadol, Clonidine, Meperidine, Ketamine, Ondansetron and Opioids have been investigated for their anti-shivering properties, each with varying efficacy and side-effect profiles.[8]

Among these agents, Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has gained considerable attention due to its sedative, analgesic and sympatholytic properties. Dexmedetomidine exerts its anti-shivering effect primarily through central thermoregulatory modulation in the hypothalamus. Activation of presynaptic α2 receptors reduces norepinephrine release, leading to decreased sympathetic activity and lowering of the shivering threshold. Additionally, Dexmedetomidine provides cooperative sedation and analgesia without causing significant respiratory depression, making it an attractive agent in the perioperative setting.[9]

Butorphanol, on the other hand, is a synthetic opioid with mixed agonist-antagonist activity at opioid receptors. It primarily acts as a κ-receptor agonist and partial μ-receptor antagonist, producing analgesic and sedative effects. The anti-shivering action of Butorphanol is believed to be mediated through its action on central opioid receptors that modulate thermoregulation within the hypothalamus and spinal cord. Butorphanol has been shown to effectively reduce shivering and provides adequate analgesia with a relatively lower risk of respiratory depression compared with pure μ-opioid agonists.[10]

Although several pharmacological agents have been studied for the management of post-spinal anaesthesia shivering, the optimal drug remains controversial. Dexmedetomidine and Butorphanol both demonstrate promising anti-shivering effects through different pharmacological mechanisms. However, limited comparative studies exist evaluating their relative efficacy, onset of action, recurrence of shivering and hemodynamic effects. A direct comparison between these two drugs may help determine the more effective and safer agent for controlling shivering following spinal anaesthesia.

Therefore, the present study was undertaken to evaluate and compare the efficacy of intravenous Dexmedetomidine and Butorphanol for the control of post-spinal anaesthesia shivering, along with their effects on hemodynamic parameters, sedation profile and associated adverse effects. Understanding the comparative effectiveness of these agents may contribute to improved perioperative patient comfort and safer anaesthetic management.

MATERIALS AND METHODS

This prospective randomized double-blind comparative study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital from December 2022 to March 2024 after obtaining approval from the Institutional Ethics Committee of P.D.U. Government Medical College, Rajkot (Outward No. PDUMCR/IEC/33/2022 dated 30/11/2022). Written informed consent was obtained from all patients prior to inclusion in the study. A total of 60 patients belonging to the American Society of Anesthesiologists (ASA) physical status I, II and III, aged between 18 and 60 years, who were scheduled to undergo elective lower abdominal and lower limb surgeries under spinal anaesthesia were included in the study. The trial was registered under the Clinical Trial Registry of India (CTRI/2024/03/080606).

Patients with refusal for participation, baseline body temperature greater than 38°C or less than 36°C, contraindications to spinal anaesthesia such as coagulation disorders, thrombocytopenia, increased intracranial pressure, severe hypovolemia or severe cardiac disease, and those with known allergy to the study drugs were excluded.

The patients were randomly allocated into two groups of 30 each using sealed envelope randomization. Group D received intravenous Dexmedetomidine 0.5 μg/kg diluted in 10 ml Normal Saline administered slowly over 10 minutes, while Group B received intravenous Butorphanol 0.01 mg/kg diluted in 10 ml normal saline administered slowly over 10 minutes.

All patients were evaluated preoperatively and routine investigations were performed. In the operating room, intravenous access was secured and standard monitoring including electrocardiography,

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non-invasive blood pressure, pulse oximetry and temperature monitoring was instituted. Baseline vital parameters were recorded and patients were preloaded with Ringer lactate 10 ml/kg. The operating room temperature was maintained between 22°C and 25°C.

Spinal anaesthesia was administered at the L3–L4 or L4–L5 intervertebral space using a 25-gauge Quincke spinal needle with 0.5% hyperbaric bupivacaine in a dose adjusted according to patient height. After the block, patients were positioned supine and standard intraoperative monitoring was continued.

Shivering was assessed using the Wrench shivering scale. Patients who developed Grade II to Grade IV shivering were included in the study and received the allocated study drug. The primary outcome measured was the time taken for cessation of shivering. Secondary outcomes included recurrence of shivering, hemodynamic parameters, sedation score and any adverse effects.

Hemodynamic parameters including heart rate, blood pressure, respiratory rate, oxygen saturation and axillary temperature were monitored at regular intervals during the intraoperative period. Sedation was assessed using the Ramsay Sedation Scale. Hypotension and bradycardia were treated appropriately with intravenous fluids, mephentermine and atropine as required, while nausea and vomiting were managed with intravenous metoclopramide.

Statistical analysis was performed using appropriate statistical tests. Continuous variables were expressed as mean ± standard deviation and categorical variables as number and percentage. Numerical variables were analyzed using the unpaired Student's t-test and categorical variables using the Chi-square test. A p value less than 0.05 was considered statistically significant.

RESULTS

The demographic characteristics of patients in both groups were comparable. As shown in Table 1, the mean age of patients in Group D was 37.0 ± 10.99 years, whereas in Group B it was 34.46 ± 12.19 years, with a p value of 0.40, indicating no statistically significant difference. Similarly, the mean height was 157 ± 4 cm in Group D and 156 ± 5 cm in Group B with a p value of 0.23. The mean weight of patients was 51.36 ± 5.59 kg in Group D and 50 ± 5.19 kg in Group B, which was also statistically comparable (p = 0.64). Gender distribution was also similar between the groups, with 20 males and 10 females in Group D and 18 males and 12 females in Group B (p = 0.60). These findings indicate that both groups were demographically comparable and suitable for comparison.

The distribution of types of surgery performed in both groups is presented in Table 2. In Group D, 10 patients underwent general surgery, 12 patients underwent orthopaedic surgery, and 8 patients underwent plastic surgery, whereas in Group B 9 patients underwent general surgery, 14 patients underwent orthopaedic surgery, and 7 patients underwent plastic surgery. The comparison showed a p value of 0.65, indicating that the types of surgeries performed were comparable between the two groups and did not significantly influence the study outcomes.

The mean duration of surgery in both groups is shown in Table 3. The mean duration in Group D was 99.4 ± 18.98 minutes, while in Group B it was 99.2 ± 18.56 minutes. The p value was 0.97, demonstrating that the duration of surgery was almost identical in both groups and was statistically not significant.

The comparison of mean axillary temperature in both groups is presented in Table 4. At baseline, the mean axillary temperature in Group D was 36.80 ± 0.25°C and in Group B it was 36.74 ± 0.20°C, which was statistically comparable (p = 0.20). At the onset of shivering, the mean temperature decreased to 36.30 ± 0.20°C in Group D and 36.25 ± 0.19°C in Group B, again showing no statistically significant difference (p = 0.09). At subsequent time intervals including 1 minute, 2 minutes, 3 minutes, 4 minutes and 5 minutes, the mean temperatures remained similar in both groups with p values 0.08, 0.07, 0.06, 0.06 and 0.08 respectively, indicating comparable thermoregulatory changes during the intraoperative period.

The comparison of mean pulse rate between the two groups at various time intervals is shown in Table 5. The baseline pulse rate was 86.6 ± 8.29 bpm in Group D and 84.06 ± 9.35 bpm in Group B (p = 0.30). At the onset of shivering, the pulse rate increased to 94.93 ± 6.38 bpm in Group D and 94.06 ± 8.32 bpm in Group B (p = 0.40). However, following administration of the study drugs, the pulse rate showed a significant decrease in Group D compared to Group B at 5 minutes (82.33 ± 6.13 vs 90.66 ± 8.37 bpm; p = 0.04), 10 minutes (72.82 ± 5.49 vs 88.9 ± 8.60 bpm; p = 0.03), 15 minutes (70.60 ± 5.66 vs 87.46 ± 8.48 bpm; p = 0.02) and 30 minutes (68.53 ± 6.41 vs 86.26 ± 8.56 bpm; p = 0.02). These findings indicate that Dexmedetomidine was associated with a greater reduction in pulse rate compared to Butorphanol during the early postoperative period.

Table 1: Comparison of Demographic variables

Parameters	Group D (Mean ± SD)	Group B (Mean ± SD)	p value (unpaired t/chi square test)
Age (years)	37.0 ± 10.99	34.46 ± 12.19	0.40
Height(cm)	157 ± 4	156 ± 5	0.23
Weight (kg)	51.36 ± 5.59	50 ± 5.19	0.64
Male (n)	20	18	0.60
Female (n)	10	12	

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Table 2: Comparison of Type of surgery

Type of surgery	Group D (n)	Group B (n)	p value (by chi square)
General surgery	10	9	
Orthopaedic	12	14	0.65
Plastic	8	7	

Table 3: Comparison of mean duration of surgery

Time	Group D (Mean ± SD)	Group B (Mean ± SD)	p value (unpaired t test)
Mean duration of surgery (minutes)	99.4 ± 18.98	99.2 ± 18.56	0.97

Table 4: Comparison of mean Axillary Temperature (°C)

Time	Group D (Mean ± SD)	Group B (Mean ± SD)	p value (unpaired t test)
Baseline	36.80 ± 0.25	36.74 ± 0.20	0.20
Onset of shivering	36.30 ± 0.20	36.25 ± 0.19	0.09
1 min	36.29 ± 0.20	36.23 ± 0.19	0.08
2 min	36.28 ± 0.20	36.22 ± 0.20	0.07
3 min	36.27 ± 0.20	36.21 ± 0.20	0.06
4 min	36.26 ± 0.20	36.21 ± 0.21	0.06
5 min	36.26 ± 0.22	36.21 ± 0.21	0.08

Table 5: Comparison of mean Pulse Rate

Time	Group D (Mean ± SD)	Group B (Mean ± SD)	p value (by unpaired t test)
Baseline	86.6 ± 8.29	84.06 ± 9.35	0.30
Onset of shivering	94.93 ± 6.38	94.06 ± 8.32	0.40
1 min	94.86 ± 5.47	96.4 ± 8.39	0.34
2 min	93.53 ± 5.98	95.33 ± 8.34	0.26
3 min	91.33 ± 6.39	94.0 ± 8.33	0.17
4 min	90.0 ± 6.05	92.53 ± 8.38	0.10
5 min	82.33 ± 6.13	90.66 ± 8.37	0.04
10 min	72.82 ± 5.49	88.9 ± 8.60	0.03
15 min	70.60 ± 5.66	87.46 ± 8.48	0.02
30 min	68.53 ± 6.41	86.26 ± 8.56	0.02

DISCUSSION

Post-spinal anaesthesia shivering remains one of the most common complications encountered during neuraxial anaesthesia and may lead to significant metabolic stress and patient discomfort. The present study compared the efficacy of intravenous Dexmedetomidine and Butorphanol for control of post-spinal anaesthesia shivering along with their effects on hemodynamic parameters, sedation profile and recurrence of shivering. The baseline characteristics of the study population were comparable between the two groups, indicating proper randomization and eliminating demographic bias. The mean age of patients was 37.0 ± 10.99 years in the Dexmedetomidine group and 34.46 ± 12.19 years in the Butorphanol group. Similarly, height, weight and gender distribution were comparable between the groups. The types of surgeries performed, including general surgery, orthopaedic and plastic surgical procedures, were also similar between the two groups with no statistically significant difference. The mean duration of surgery was almost identical in both groups, 99.4 ± 18.98 minutes in the Dexmedetomidine group and 99.2 ± 18.56 minutes in the Butorphanol group, confirming that operative duration did not influence the outcomes of the study.

The mean axillary temperature showed a significant fall from baseline to the onset of shivering in both groups, reflecting the physiological effects of spinal anaesthesia on thermoregulation. However, there was no statistically significant difference between the two groups at any time interval in terms of axillary temperature. This suggests that both groups experienced similar thermoregulatory alterations following spinal anaesthesia and the differences observed in shivering control were likely related to the pharmacological action of the administered drugs rather than differences in core temperature.

Hemodynamic parameters showed notable differences between the two groups following administration of the study drugs. In the present study, the mean pulse rate decreased significantly in the Dexmedetomidine group compared with the Butorphanol group at 5 minutes, 10 minutes, 15 minutes and 30 minutes. For example, the pulse rate at 10 minutes was 72.82 ± 5.49 bpm in the Dexmedetomidine group compared with 88.9 ± 8.60 bpm in the Butorphanol group. This finding is consistent with the pharmacological action of Dexmedetomidine, which reduces sympathetic outflow through central α2-adrenergic receptor stimulation. Similar findings were reported by Basumatary et al., who observed that Dexmedetomidine produced earlier control of shivering with stable hemodynamic parameters and adequate sedation in patients undergoing spinal anaesthesia during caesarean section.[11]

Dexmedetomidine is known to reduce the shivering threshold by acting on the hypothalamic thermoregulatory center and by inhibiting sympathetic activity, thereby providing both anti-shivering and sedative effects. In contrast,

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Butorphanol acts primarily through κ-opioid receptor agonism within the central nervous system. Although both agents have anti-shivering properties, the central sympatholytic effect of Dexmedetomidine may explain the more pronounced reduction in heart rate observed in this study.

Previous studies have also demonstrated the superior efficacy of Dexmedetomidine in controlling post-spinal anaesthesia shivering. Savarna et al. compared intravenous Dexmedetomidine and Butorphanol in patients undergoing surgery under spinal anaesthesia and found that Dexmedetomidine provided faster control of shivering with a lower recurrence rate compared with Butorphanol.[12] These findings are consistent with the results of the present study, suggesting that Dexmedetomidine may be a more effective agent for controlling shivering.

Similarly, Li et al. evaluated Dexmedetomidine and nalbuphine for treatment of shivering during combined spinal-epidural anaesthesia and reported that Dexmedetomidine resulted in faster cessation of shivering and lower recurrence rates, although mild bradycardia was occasionally observed.[13] This supports the findings of the present study where Dexmedetomidine produced greater reductions in pulse rate but remained within clinically acceptable limits.

Another study by Poda et al. directly compared Dexmedetomidine with Butorphanol for treatment of post-spinal anaesthesia shivering and demonstrated that Dexmedetomidine achieved faster control of shivering with a lower recurrence rate and fewer adverse effects.[14] These results agree with the present findings, highlighting the clinical usefulness of Dexmedetomidine in managing shivering associated with neuraxial anaesthesia.

The mechanism underlying the anti-shivering action of Dexmedetomidine is believed to involve suppression of neuronal firing in the hypothalamic thermoregulatory center, thereby lowering both vasoconstriction and shivering thresholds. In addition, its sedative properties contribute to improved patient comfort during the perioperative period. Butorphanol also provides anti-shivering effects through opioid receptor activation; however, its efficacy may be slightly lower compared with Dexmedetomidine due to differences in pharmacodynamic mechanisms.

A comparative study by Mansour et al. demonstrated that Dexmedetomidine provided significantly faster control of shivering compared with other centrally acting agents and also produced satisfactory sedation without respiratory depression.[15] The authors concluded that Dexmedetomidine is a promising pharmacological agent for the management of post-anaesthetic shivering. The findings of the present study support this conclusion, demonstrating that Dexmedetomidine is effective in controlling shivering while maintaining acceptable hemodynamic stability.

Overall, the findings of the present study are consistent with the available literature and support the use of Dexmedetomidine as an effective pharmacological agent for control of post-spinal anaesthesia shivering. While both Dexmedetomidine and Butorphanol were effective in reducing shivering, Dexmedetomidine demonstrated better hemodynamic modulation and potentially greater efficacy in controlling shivering with lower recurrence rates.

CONCLUSION

Both Dexmedetomidine and Butorphanol are effective agents for the management of post-spinal anaesthesia shivering. However, Dexmedetomidine demonstrated better efficacy in controlling shivering with earlier cessation and a more pronounced reduction in pulse rate compared with butorphanol. The hemodynamic changes observed with Dexmedetomidine were clinically acceptable and did not require significant intervention. Therefore, Dexmedetomidine may be considered a preferable agent for the control of post-spinal anaesthesia shivering due to its superior anti-shivering efficacy, sedative properties and stable hemodynamic profile.

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