Original Article

Intrathecal Dexmedetomidine versus Nalbuphine as an Adjuvant to 0.5% Hyperbaric Bupivacaine in Lower Abdominal and Lower Limb Surgeries

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Abstract

Background: The use of adjuvants is common for intrathecal bupivacaine to improve the quality and duration of spinal anesthesia. Commonly used adjuvants include dexmedetomidine and nalbuphine; however, their comparative efficacy and safety profiles remain limited. Therefore, we aimed to compare intrathecal dexmedetomidine and nalbuphine as adjuvants to 0.5% hyperbaric bupivacaine in patients undergoing elective lower abdominal and lower limb surgeries. **Material and Methods:** A total of 60 cases of lower abdominal and lower limb surgeries were selected and randomly allotted to two equal groups. Group 2: dexmedetomidine was given in this group as Inj.0.5% Hyperbaric Bupivacaine (15mg) + Inj. Dexmedetomidine (10µg) intrathecally. The patients in this group were given Inj. nalbuphine. 0.5% Hyperbaric Bupivacaine (15mg) + Inj. Nalbuphine (0.8mg) intrathecally. Parameters compared included duration of onset, duration of sensory and motor block, duration of analgesia, and maximum level of sensory block, as well as hemodynamic parameters. Statistical analysis was done to determine the significance between the two groups. **Results:** Dexmedetomidine produced a significantly faster onset of sensory block (3.0 ± 0.83 min vs 4.47 ± 1.01 min) and motor block (5.07 ± 0.87 min vs 6.57 ± 1.01 min) compared to nalbuphine ($p < 0.001$). The duration of sensory block (323.13 ± 27.21 min vs 268.93 ± 23.68 min), motor block (294.53 ± 25.94 min vs 240.53 ± 23.45 min), and analgesia (353.13 ± 26.40 min vs 299.27 ± 23.26 min) was significantly longer with dexmedetomidine ($p < 0.001$). Hemodynamic parameters remained comparable between groups ($p > 0.05$). A higher proportion of patients achieved T4 sensory blockade with dexmedetomidine, though the difference was not statistically significant ($p = 0.086$). **Conclusion:** The results of this study showed that intrathecal dexmedetomidine appears superior as an adjuvant to nalbuphine, owing to its faster onset of action, prolonged spinal anesthesia, and hemodynamic stability.

Keywords: Dexmedetomidine, Nalbuphine, Spinal anesthesia, Intrathecal adjuvant, Bupivacaine.

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Introduction

Pain during surgery is often underestimated and undertreated. As a subjective experience, its intensity varies widely among patients, largely because of its emotional component. Pain alleviation during surgery is the very foundation of anaesthesiology.[1] The expertise anaesthesiologists gain in managing intraoperative pain should ideally extend into the postoperative period, where it offers significant benefits for patient recovery.[2] Postoperative pain management is a critical aspect of patients' overall recovery. Unfortunately, it has been given less care than it deserves. Various methods have been employed to manage perioperative and postoperative pain effectively.[2] Regional anaesthesia techniques have gained prominence due to their cost-effectiveness, ease of administration, and minimal equipment requirements compared to general anaesthesia. These techniques are particularly advantageous in settings where anaesthesia gases and drugs may not be readily available. Among regional techniques, the subarachnoid block (spinal anaesthesia) has achieved immense popularity, especially for lower abdominal and orthopaedic surgeries.[3] In addition to reducing perioperative blood loss, which lessens the need for donor blood and its associated issues, spinal anaesthesia provides deep muscular relaxation, making it ideal for intra-abdominal and orthopaedic surgeries. Its ease of use, high success rate, quick start, and benefit of keeping the patient alert and cooperative are the key reasons for its popularity.[3] A common technique is spinal anaesthesia with 0.5% hyperbaric bupivacaine. It is an extremely frequent practice to combine opioids with local anaesthetics. This kind of combination may result in other unwanted issues, including itching, nausea and vomiting, or respiratory depression, even while the opioids lessen the toxicity and cardiovascular effects of local anaesthetics.[4] There is a clear

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role for intrathecal opioids as adjuncts in the current practice of regional anaesthesia. Numerous opioids have been used with buprevacaine to prolong its effects, improve the quality of analgesia, and lessen the need for postoperative analgesic.[4] A semisynthetic opioid with a combination of k agonist and μ antagonist effects is nalbuphine. According to earlier research by Mukherjee et al,[5] and Sapate et al,[6] intrathecal nalbuphine results in notable analgesia with minimal itching and minimal respiratory depression. Different nalbuphine dosages were tested; the optimal dosage remains under debate. These days, hyperbaric bupivacaine is used in tiny doses with a variety of different medications to provide analgesia that is quicker, more severe, and has longer sensory and motor blockage. Alpha-2 agonists may increase the effects of local anaesthetics and have analgesic qualities. Adding opioids or alpha-2 agonists as adjuvants significantly reduces the need for perioperative anaesthesia and analgesia.[7,8] When administered intrathecally, the alpha 2 agonist dexmedetomidine has been shown to lengthen the duration of spinal anaesthesia. Intrathecal alpha 2 receptor agonists have been shown to have antinociceptive effects on both visceral and somatic pain fibres.[9] In human spinal anaesthesia, small doses of dexmedetomidine combined with bupivacaine have been shown to result in a quicker onset of motor block, longer duration of motor and sensory block, haemodynamic stability, and a reduced rate of sedation.[10] In their prospective randomized controlled studies, Eid et al,[11] and Al-Mustafa et al,[12] reported a positive dose-related effect of intrathecal dexmedetomidine with hyperbaric bupivacaine. We designed the present study to test the efficacy of intrathecal dexmedetomidine and intrathecal nalbuphine hydrochloride as adjuvants to 0.5 percent hyperbaric bupivacaine in lower abdominal and lower limb surgeries.

Materials and Methods

This prospective observational study was conducted in the Department of Anesthesiology at Kamineni Institute of Medical Sciences, Narketpally, Telangana. The study was carried out from April 2023 to March 2025. Institutional Ethical approval was obtained for the study. The study was done on patients scheduled for elective lower abdominal and Lower limb surgeries. The samples were collected using convenience sampling, with inclusion and exclusion criteria. Written informed consent was obtained from all the cases of the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion criteria

1. Patients undergoing elective lower abdominal and lower limb surgeries.
2. ASA I and II categories
3. Aged above 18 years
4. No history of allergy or sensitivity to Local anesthetics
5. Gave informed consent

Exclusion criteria

1. History of significant medical conditions such as heart disease, hypertension
2. ASA grade III and above
3. People using anticoagulant medication
4. Spinal abnormalities or local infection at the spinal anaesthesia puncture site
5. Unwilling to willingly engage in the research.

Considering the inclusion and exclusion criteria, a total of n=60 patients with ASA grade 1 & 2 classification, aged 20-60 years, were randomly divided into two equal groups based on the kind of adjuvant that was substituted for the local anaesthetic. They were randomly allotted to two equal groups of n=30 each. Group dexmedetomidine - Patients in this group were given Inj.0.5% Hyperbaric Bupivacaine (15mg) + Inj. Dexmedetomidine (10μg) intrathecally. Group N - Patients in this group were given Inj.0.5% Hyperbaric Bupivacaine (15mg) + Inj. Nalbuphine (0.8mg) intrathecally.

Preanesthetic evaluation was performed by obtaining a detailed history, performing a clinical examination, and conducting investigations, including CBC with coagulation profile, liver and kidney function tests, ECG, fasting blood sugar, chest X-ray, PA view, and all patients were kept nil by mouth for 8 hours before surgery.

Brief description of the anaesthetic technique: The patient was moved to the operating room around twenty minutes ahead of schedule on the day of the procedure. Standard monitoring was started upon the patient's entry into the operating room, including peripheral oxygen saturation, non-invasive arterial blood pressure, and ECG lead II. An 18-gauge intravenous cannula was inserted and secured. pre-drug as an injection. In addition to Ringer's lactate solution administered as a pre-load at 10 mg/kg, 4 mg of ondansetron and 1 mg of intravenous midazolam were administered. In group D, 30 patients will receive 3 millilitres of 0.5% hyperbaric bupivacaine together with 10 micrograms of dexmedetomidine. Three millilitres of 0.5% hyperbaric bupivacaine will be administered together with 0.8 mg of nalbuphine to the remaining 30 individuals in group N. Following pre-loading, the spinal method was applied: spinal anaesthesia.

The lateral decubitus posture was used for the patients. The patient's back was painted and draped using spirit and betadine solution. The intercrestal line, which runs across the L3-L4 intervertebral region, was used to identify the level. At the L3-4 or L4-5 interspace, a 25-G spinal needle was placed in the midline. The unrestricted flow of cerebrospinal fluid indicated proper needle insertion after penetration of the ligamentum flavum, dura mater, and arachnoid mater. Over 10 to 15 seconds, the appropriate local anaesthetic solution was delivered. Following the injection, the patient was put in a supine position for fifteen minutes. Using a blunt-tipped 27G needle and the pinprick method, sensory blockade was tested every minute for the first five minutes, then every five minutes for the next fifteen, then every ten minutes for the next thirty, and then every fifteen minutes until the end of surgery, and finally every thirty minutes until the sensory block is resolved.

The modified Bromage scale was used to evaluate the quality of motor blockage. Noted were the extent of anaesthesia, the length of the procedure, and if any adverse effects occurred. Using a multiparameter monitor that shows heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), electrocardiogram (ECG), and SpO2 hourly, haemodynamic monitoring was performed during the

block every five minutes for the first fifteen minutes, every ten minutes for the next thirty minutes, and once every fifteen minutes until the end of surgery and post-operatively every hourly. The interval between the completion of the study medication injection and the patient no longer feeling the pinprick at the T10 level is known as the "onset of sensory blockade." The amount of time between finishing the study medication injection and reaching the greatest level of sensory blockage is known as the time required for maximal sensory blockade. The interval between finishing the injection of the study medication and the patient developing Bromage-1 is known as the "onset and quality of motor blockade." The modified Bromage scale was used to evaluate the quality of motor blockade: Bromage 0: The patient can move their ankle, knee, and hip. In Bromage 1, the patient can move the knee and ankle but not the hip; in Bromage 2, the patient can move the ankle but not the hip or knee. Bromage 3: The patient's ankle, knee, and hip cannot move. The amount of time between finishing the study drug injection and reaching the maximum motor blockade is known as the time required for maximum motor blockade. The amount of time between reaching the maximal level of sensory block and the feeling regressing by two segments is known as the duration of two-segment sensory regression. The amount of time that passes between finishing the study medication injection and the patient requesting a rescue analgesic during the postoperative phase is known as the duration of analgesia.

The time between injection and the patient's first sensation in the S1 dermatome is known as the duration of sensory blockage. The time between injection and the patient's full motor recovery is known as the duration of motor blockage. Sedation level: A Ramsay Sedation Scale was used to measure the degree of sedation. Cardiovascular side effects, such as variations in blood pressure, heart rate, and rhythm, central nervous system depression, respiratory depression, and any medication hypersensitivity responses, will be seen in patients. Statistical analysis: All available data were refined, segregated, and uploaded to an MS Excel spreadsheet, and analyzed using SPSS version 26 in Windows. To assess differences between the two groups, the chi-square test was used for categorical variables, while continuous variables were reported as means, standard deviations, and percentages. Significant results were defined as $p < 0.05$.

Results

[Table 1] provides the demographic characteristics of the group that was part of the investigation. A critical analysis of the table showed that the mean age of the dexmedetomidine group was 41.00 ± 3.2 years, and the mean age of the nalbuphine group was 40 ± 2.5 years; there were no significant differences between the two groups in age distribution. Similarly, the gender distribution of cases showed male dominance in both groups; however, the intergroup difference was not significant. The BMI categories of the cases in the study showed that 70–80% were in the normal weight category, and the intergroup comparison of differences was not significant. This showed a good randomization of the cases for comparison, and the outcome values will be due to the drug used rather than confounding factors.

Table 1: Demographic Characteristics of Study Groups

Characteristic	Dexmedetomidine Group (n =30)	Nalbuphine Group (n= 30)	p-value
Age (Years)			
≤ 30	9 (30.0%)	7 (23.33%)	0.354
31-40	10 (33.33%)	12 (40.0%)	
> 41	11 (36.67%)	11 (36.67%)	
Mean Age ± SD	41.00 ± 3.2	40.03 ± 2.5	
Sex			
Male	22 (73.33%)	23 (76.67%)	0.897
Female	8 (26.67%)	7 (23.33%)	
BMI Category			
Underweight	1 (3.3%)	0 (0%)	0.752
Normal	25 (83.33%)	23 (76.67%)	
Overweight	4 (13.33%)	6 (20.00%)	
Obese	0 (0.0%)	1 (3.3%)	

The analysis of the onset characteristics of spinal block in the two groups of cases is presented in [Table 2]. A critical analysis of the table showed that the dexmedetomidine group had a faster onset of sensory block (3.0 ± 0.83 min) than the nalbuphine group (4.47 ± 1.01 min), with a significant difference ($p < 0.05$). Similarly, the onset of motor block was earlier in the dexmedetomidine group than in the nalbuphine group (5.07 ± 0.87 vs 6.57 ± 1.01), with a significant difference ($p = 0.001$).

The time to maximum block in the dexmedetomidine group was faster than in the nalbuphine group, with a significant difference (p-value). Similarly, the time to sensory block was shorter in the dexmedetomidine group than in the nalbuphine group.

Table 2: Onset Characteristics of Spinal Block

Parameter	Dexmedetomidine Group (Mean ± SD)	Nalbuphine Group (Mean ± SD)	p-value
Onset of Sensory Block (min)	3.0 ± 0.83	4.47 ± 1.01	< 0.001*
Onset of Motor Block (min)	5.07 ± 0.87	6.57 ± 1.01	< 0.001*
Time to Maximum Motor Block (min)	6.7 ± 0.7	8.37 ± 0.77	< 0.001*
Time to Maximum Sensory Block (min)	6.1 ± 0.76	7.67 ± 0.88	< 0.001*
*Significant			

The distribution of maximum sensory block levels is shown in [Table 3]. A critical analysis of the table shows that 2 out of 30 patients in the N group (Nalbuphine group) and 8 out of 30 patients in the dexmedetomidine group had a T4 level of sensory blockade. 4 out of 30 patients in the nalbuphine group and 5 out of 30 in the dexmedetomidine group had T5 sensory blockade. Twenty-four out of 30 patients in the nalbuphine group, 17 out of 30 patients in the dexmedetomidine group had a T6 level of sensory blockade. The highest level of sensory blockade is observed in the Dexmedetomidine group. There are no differences between the groups that are statistically significant. (p=0.086).

Table 3: Maximum Sensory Block Level Distribution

Maximum Sensory Level	Dexmedetomidine Group (n=30)	Nalbuphine Group (n=30)
T4	8 (26.67%)	2 (6.67%)
T5	5 (16.67%)	4 (13.33%)
T6	17 (56.67%)	24 (80.00%)
p-value	0.086 (NS)	

[Table 4] shows the spinal block characteristics of the two groups in the study. Analysis of the table showed that the mean time taken for the maximum sensory blockade was 7.67 minutes in the nalbuphine group and 6.10 minutes in the dexmedetomidine group. There was a statistically significant difference between the nalbuphine and dexmedetomidine groups. (p <0.001). The mean time taken to achieve maximum sensory blockade was shorter in the dexmedetomidine group. Regression of the sensory block by two segments took an average of 120.5000 minutes in the group treated with N and 146.03 minutes in the group treated with dexmedetomidine. The difference between the nalbuphine and dexmedetomidine groups was statistically significant (p<0.001). The dexmedetomidine group had a longer mean time for regression of the sensory block by two segments. The mean length of sensory regression to S1 was 323.13 minutes in group D (dexmedetomidine group) compared to 268.93 minutes in the nalbuphine group. The difference between groups N and D was statistically significant (p <0.001). The dexmedetomidine group had sensory regression for a longer period of time on average. The minimal motor block duration was 205 min in the nalbuphine group and 231 min in the dexmedetomidine group. The maximum duration of motor block was 293 min in group N and 330 min in group D. The maximum motor block duration was longer in the dexmedetomidine group. There was a statistically significant difference between groups N and D (p <0.001). The mean duration of analgesia was 299.26 min in group N (nalbuphine group) and 353.13 min in group D (dexmedetomidine group). The difference between groups N and D is extremely significant (p < 0.001). The dexmedetomidine group had analgesia for a longer period of time.

Table 4: Duration Characteristics of Spinal Block

Parameter	Dexmedetomidine Group (Mean ± SD)	Nalbuphine Group (Mean ± SD)	p-value
Two-Segment Regression Time (min)	146.03 ± 20.24	120.5 ± 19.4	<0.001*
Duration of Sensory Block (min)	323.13 ± 27.21	268.93 ± 23.68	<0.001*
Duration of Motor Block (min)	294.53 ± 25.94	240.53 ± 23.45	<0.001*
Duration of Analgesia (min)	353.13 ± 26.4	299.27 ± 23.26	<0.001*
*Significant			

Except for a non-significant rise in pulse rate up to 3 minutes in the nalbuphine group, patients' pulse rates in both groups remained below baseline throughout the trial [Table 5]. Throughout the investigation, no discernible intergroup differences were found. (p>0.05) Throughout the research period, both groups' systolic blood pressure remained below baseline, with no discernible difference between the groups. Diastolic blood pressure did not differ significantly between groups during the study and remained below baseline values (p>0.05). This suggests that mean arterial blood pressure did not differ significantly between groups during the study and remained below baseline values (p>0.05).

Table 5: Hemodynamic Parameters at Selected Time Points

Time Point	Parameter	Dexmedetomidine Group (Mean ± SD)	Nalbuphine Group (Mean ± SD)	p-value
Baseline	Heart Rate (bpm)	89.73 ± 17.27	84.33 ± 16.02	0.214
	SBP (mmHg)	124.27 ± 13.55	128.3 ± 7.83	0.181
	DBP (mmHg)	81.67 ± 9.73	84.47 ± 6.51	0.195
	MAP (mmHg)	96.03 ± 9.06	96.60 ± 8.46	0.803
10 min	Heart Rate (bpm)	74.4 ± 13.88	81.67 ± 19.48	0.101
	SBP (mmHg)	106.93 ± 14.51	113.47 ± 8.05	0.035
	DBP (mmHg)	68.33 ± 12.37	72.00 ± 8.19	0.181
	MAP (mmHg)	82.53 ± 10.46	86.00 ± 7.07	0.138
30 min	Heart Rate (bpm)	75.33 ± 9.25	76.8 ± 14.66	0.622
	SBP (mmHg)	108.00 ± 10.66	111.2 ± 12.6	0.293
	DBP (mmHg)	70.53 ± 9.16	70.13 ± 7.63	0.855
	MAP (mmHg)	82.80 ± 8.76	83.97 ± 6.93	0.570

60 min	Heart Rate (bpm)	78.63 ± 11.86	79.93 ± 9.40	0.640
	SBP (mmHg)	112.60 ± 9.01	117.13 ± 9.49	0.063
	DBP (mmHg)	72.67 ± 5.69	72.87 ± 10.53	0.927
	MAP (mmHg)	85.30 ± 6.22	86.47 ± 8.44	0.544
90 min	Heart Rate (bpm)	79.77 ± 10.41	79.29 ± 10.46	0.853
	SBP (mmHg)	111.33 ± 11.29	116.53 ± 9.51	0.059
	DBP (mmHg)	71.87 ± 5.94	76.23 ± 14.33	0.129
	MAP (mmHg)	86.80 ± 5.16	85.63 ± 8.98	0.540

The key comparison between the two patient groups is presented in [Table 6]. Overall, results showed that dexmedetomidine demonstrated a significantly quicker onset of both sensory and motor blockade compared with nalbuphine. Dexmedetomidine provided a longer duration of sensory block, motor block, and postoperative analgesia. Both adjuvants maintained hemodynamic stability with no clinically significant differences in heart rate or blood pressure. Dexmedetomidine showed a trend toward higher maximum sensory block levels (more T4 blocks), though this was not statistically significant. The two-segment regression time was significantly longer with dexmedetomidine, indicating more prolonged surgical anesthesia. Both groups achieved adequate motor blockade (Bromage grade 3) with no differences in quality.

Table 6: Summary of key comparative outcomes

Outcome	Dexmedetomidine	Nalbuphine	P value
Onset time	3.0	4.47	<0.001*
Block duration	323.1	268.9	<0.001*
Analgesia duration	353.1	299.3	<0.001*
Hemodynamic stability	Comparable	Comparable	-
Sensory block level	Higher (more T4 block)	Lesser	0.084
*Significant			

Discussion

The present study was conducted to compare the efficacy and safety of intrathecal dexmedetomidine and nalbuphine when used as adjuvants to 0.5% hyperbaric bupivacaine spinal anesthesia in those undergoing elective lower abdominal and lower limb surgeries. [Table 1] presents the demographic characteristics of the two groups. The analysis of the table showed that the two groups were comparable for all parameters, indicating adequate randomization and minimizing the influence of confounding factors on the outcomes. Therefore, the differences in the outcomes between the two groups will be attributed to the pharmacological properties of the two adjuvants in question. Compared with nalbuphine, dexmedetomidine produced a much earlier onset of sensory and motor blocks, as indicated by the sensory and motor block characteristics. These results are consistent with what earlier research has shown where they found dexmedetomidine which is a highly selective alpha-2 agonist enhanced the actions of local anesthetics primarily by inhibiting C nociceptor transmission and also caused hyperpolarization of dorsal horn neurons causing faster block onset,[12,13] nalbuphine is a κ-opioid and μ-opioid receptor agonist which is known to augment spinal anesthesia however the actions appear to occur slowly delaying the onset as compared to dexmedetomidine.[14] Our study demonstrated that the duration of action of dexmedetomidine is significantly longer than that of nalbuphine for sensory block, motor block, and postoperative analgesia. The increased two-segment regression time and delayed sensory regression to S1 observed in the dexmedetomidine group suggest more sustained spinal anesthesia. This extended analgesia duration is clinically advantageous because it reduces the need for early postoperative rescue analgesics.

Al Mustafa et al,[11] and Kanazi et al,[10] have also reported similar effects of intrathecal dexmedetomidine on sensory and motor blockade when combined with bupivacaine. Nalbuphine, despite its efficacy in prolonging analgesia, has a relatively short duration of action, consistent with other reports showing that it has moderate efficacy as an intrathecal opioid adjuvant.[5] The maximum sensory block level was higher in the dexmedetomidine group, with a greater proportion of patients achieving T4 blockade, although this difference was not statistically significant. This trend suggests that dexmedetomidine may facilitate a higher cephalad spread of sensory block, possibly due to its synergistic interaction with bupivacaine. This tendency indicates that dexmedetomidine could enhance an increase in cephalad spread of sensory block, possibly because of its synergistic activity with bupivacaine. The same has been observed in previous research, in which dexmedetomidine did not increase adverse effects, as it was associated with higher sensory levels.[15] One important factor to consider when administering intrathecal adjuvants is hemodynamic stability. In the current study, both groups maintained a constant heart rate and blood pressure during the intraoperative period, and there was no clinically significant intergroup difference [Table 5]. Even though dexmedetomidine is known to induce bradycardia and hypotension due to sympatholytic effects, the low dose of the intrathecal dose administered in this study did not lead to serious hemodynamic compromises. The results can be correlated with a prior research study reporting hemodynamic stability with low doses of intrathecal dexmedetomidine and nalbuphine.[16,17] The overall results of this study indicate that although both dexmedetomidine and nalbuphine are effective intrathecal adjuvants to hyperbaric bupivacaine, dexmedetomidine has better block properties, including rapid onset, longer sensory and motor blocks, and more

prolonged postoperative analgesia, without altering hemodynamic stability. These benefits make dexmedetomidine a better choice as an adjuvant during lower-abdomen and lower-limb surgeries.

Conclusion

For lower abdomen and lower limb procedures, we discovered that both dexmedetomidine and nalbuphine worked well as intrathecal adjuvants to 0.5% hyperbaric bupivacaine, despite the study's limitations. Nonetheless, dexmedetomidine offered the benefits of postoperative analgesia, a longer duration of sensory and motor block, and a quicker start of sensory and motor blockade. Compared with nalbuphine, it also had a longer two-segment regression time. The hemodynamic parameters in both groups were similar and showed a good safety profile. These results reinforce the evidence that dexmedetomidine appears to be a superior adjuvant compared to nalbuphine for enhancing the quality and duration of spinal anesthesia.

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Conflicts of interest

There are no conflicts of interest.

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