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Original Research Article

Comparative Effects of Intrathecal Nalbuphine and Fentanyl on Sensory and Motor Block Characteristics During Spinal Anaesthesia for Lower Limb Surgery

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Conflict of interest: Nil

Abstract

Background: Intrathecal opioids are commonly added to hyperbaric bupivacaine to improve the quality and duration of spinal anaesthesia. Fentanyl is widely used for this purpose, whereas nalbuphine, a mixed opioid agonist-antagonist, may provide prolonged analgesia with a potentially favourable adverse-effect profile. This study compared the sensory and motor block characteristics produced by intrathecal hyperbaric bupivacaine combined with fentanyl or nalbuphine in patients undergoing lower limb surgery.

Methods: This randomized prospective study was conducted in the Department of Anaesthesiology, Thumbay Hospital New Life, Hyderabad, over six months. Sixty patients aged 20–55 years with ASA physical status I or II scheduled for elective lower limb surgery under spinal anaesthesia were included. Patients were randomized into two groups of 30 each using a sealed-envelope technique. Group BUF received 3 mL of 0.5% hyperbaric bupivacaine (15 mg) with fentanyl 25 µg intrathecally, while Group BUN received 3 mL of 0.5% hyperbaric bupivacaine (15 mg) with nalbuphine 1 mg intrathecally. Sensory blockade was assessed by pinprick, while motor blockade was assessed using the modified Bromage scale.

Results: The groups were comparable in baseline characteristics. The mean onset time of sensory blockade to T10 was 4.63±1.10 minutes in the BUF group and 5.40±1.38 minutes in the BUN group, with no statistically significant difference (p=0.21). The mean duration of sensory blockade was 156.83±10.70 minutes with BUF and 159.33±12.02 minutes with BUN (p=0.39). The maximum sensory level was also comparable between groups (p=0.843), with T6 being the most frequent level in both groups. In contrast, motor blockade developed significantly earlier with fentanyl. Mean onset of motor blockade was 6.65±0.92 minutes in BUF compared with 8.78±0.89 minutes in BUN (p<0.001). The duration of motor blockade was similar, at 168.83±9.71 minutes and 170.83±9.48 minutes, respectively (p=0.42).

Conclusion: Addition of fentanyl or nalbuphine to hyperbaric bupivacaine produced comparable sensory block characteristics and duration of motor blockade. Fentanyl produced a significantly faster onset of motor blockade, whereas nalbuphine provided a similar overall block profile without prolonging motor recovery.

Keywords: Spinal Anaesthesia; Hyperbaric Bupivacaine; Fentanyl; Nalbuphine; Sensory Blockade; Motor Blockade; Lower Limb Surgery.

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Introduction

Spinal anaesthesia is widely used for lower limb surgery because it provides a reliable, dense neural blockade with rapid onset and avoids many of the disadvantages associated with general anaesthesia.[1] Hyperbaric bupivacaine 0.5% remains one of the most frequently used local anaesthetics for subarachnoid block. However, although bupivacaine provides satisfactory surgical anaesthesia, prolongation of sensory analgesia without an undesirable increase in motor or sympathetic blockade remains an important objective.[2] Intrathecal opioids act synergistically with local anaesthetics. Their addition may enhance the quality of sensory analgesia while allowing the local anaesthetic dose to remain unchanged. Fentanyl is a commonly used intrathecal opioid because of its rapid onset and lipophilic characteristics. Nalbuphine, in contrast, is a mixed

opioid agonist-antagonist with activity at kappa receptors and antagonistic activity at mu receptors. Previous studies have suggested that intrathecal nalbuphine can prolong sensory analgesia while producing relatively few opioid-related adverse effects. [3,4,5] The thesis literature review specifically identifies studies demonstrating prolonged postoperative analgesia with nalbuphine and comparable haemodynamic characteristics to fentanyl.[6,7] The present analysis therefore focused specifically on the sensory and motor characteristics of spinal blockade following addition of fentanyl or nalbuphine to hyperbaric bupivacaine.

Materials and Methods

This randomized prospective study was performed in the Department of Anaesthesiology, Thumbay Hospital New Life, Hyderabad. The study duration was six months. Sixty patients aged 20–55 years belonging to ASA physical status I or II and scheduled for lower limb surgery under spinal anaesthesia were included. Inclusion required valid informed written consent. Patients with ASA grade III or higher, significant cardiovascular, neurological, hepatic, renal or metabolic disease, age outside the specified range, known drug hypersensitivity, opioid sensitivity, coagulation disorders, contraindications to spinal anaesthesia or local sepsis were excluded.

Patients were randomized using the sealed-envelope technique into two groups of 30 patients each. Group BUF received 3 mL of 0.5% hyperbaric bupivacaine containing 15 mg plus fentanyl 25 µg intrathecally. Group BUN received 3 mL of 0.5% hyperbaric bupivacaine containing 15 mg plus nalbuphine 1 mg intrathecally.

Spinal anaesthesia was administered at the L3–L4 interspace using a 25-G spinal needle following free flow of clear cerebrospinal fluid. Sensory blockade was assessed by pinprick every 15 seconds until loss of sensation at T10. The highest sensory level was recorded at 20 minutes. Duration of sensory blockade was defined as the time from intrathecal injection until regression to T10. Motor blockade was assessed using the modified Bromage scale, with onset defined as achievement of Bromage grade 3 and duration defined as the interval until complete motor recovery to grade 0. Quantitative variables were analysed using Student's t-test and qualitative variables using the chi-square test. Statistical significance was considered according to the criteria used in the thesis.

Results

Table 1: Comparison of baseline demographic characteristics between the two groups

Characteristic	BUF Group (n=30)	BUN Group (n=30)	p value
Age (years), mean ± SD	35.90 ± 11.61	38.97 ± 10.70	0.29
Weight (kg), mean ± SD	63.50 ± 8.86	65.83 ± 7.96	0.28
Height (cm), mean ± SD	162.13 ± 6.59	162.73 ± 7.64	0.74
Female, n (%)	13 (43.3)	15 (50.0)	>0.05
Male, n (%)	17 (56.7)	15 (50.0)	>0.05
ASA I, n (%)	20 (66.7)	19 (63.3)	>0.05
ASA II, n (%)	10 (33.3)	11 (36.7)	>0.05

The two groups were comparable with respect to age, weight, height, sex and ASA physical status, with no statistically significant baseline differences.

Table 2: Comparison of sensory blockade characteristics

Sensory block parameter	BUF Group (n=30)	BUN Group (n=30)	p value
Onset of sensory block (min), mean ± SD	4.63 ± 1.10	5.40 ± 1.38	0.21
Duration of sensory block (min), mean ± SD	156.83 ± 10.70	159.33 ± 12.01	0.10*
Highest sensory level, n (%)			0.843
T4	3 (10.0)	2 (6.7)	
T5	6 (20.0)	9 (30.0)	
T6	16 (53.3)	14 (46.7)	
T7	4 (13.3)	3 (10.0)	
T8	1 (3.3)	2 (6.7)	

Sensory blockade developed slightly earlier in the BUF group than in the BUN group (4.63 vs 5.40 min), but the difference was not statistically significant. The duration of sensory blockade was also comparable. T6 was the most frequently achieved maximum sensory level in both groups, and the distribution of the highest sensory level did not differ significantly (p=0.843).

Table 3: Comparison of motor blockade characteristics

Motor block parameter	BUF Group (n=30)	BUN Group (n=30)	p value
Onset of Grade 3 motor block (min), mean ± SD	6.65 ± 0.92	8.78 ± 0.89	<0.001
Duration of Grade 3 motor block (min), mean ± SD	168.83 ± 9.71	170.83 ± 9.48	0.42
Significant difference in onset	Faster	—	Yes
Significant difference in duration	No	No	No

The onset of complete motor blockade (Modified Bromage Grade 3) was significantly faster in the BUF group than in the BUN group (6.65 ± 0.92 vs 8.78 ± 0.89 minutes; p<0.001). However, the duration of Grade 3 motor blockade was comparable between groups (168.83 ± 9.71 vs 170.83 ± 9.48 minutes; p=0.42).

Table 4: Sensory and motor block characteristics

Parameter	BUF: Bupivacaine + Fentanyl	BUN: Bupivacaine + Nalbuphine	p value
Sensory block onset (min)	4.63±1.10	5.40±1.38	0.21
Sensory block duration (min)	156.83±10.70	159.33±12.02	0.39
Motor block onset (min)	6.65±0.92	8.78±0.89	<0.001
Motor block duration (min)	168.83±9.71	170.83±9.48	0.42

The onset of sensory blockade was comparable between groups. The mean sensory onset was 4.63 minutes in BUF and 5.40 minutes in BUN (p=0.21).

The mean duration of sensory blockade was 156.83±10.70 minutes in BUF and 159.33±12.015 minutes in BUN, without a statistically significant difference (p=0.39).

The highest sensory level was also comparable. T6 was achieved in 53.3% of BUF patients and 46.7% of BUN patients, followed by T5 in 20.0% and 30.0%, respectively. There was no significant difference in maximum sensory level (p=0.843).

Motor blockade developed significantly earlier with fentanyl. The mean onset was 6.65±0.92 minutes in BUF compared with 8.78±0.89 minutes in BUN (p<0.001). However, the duration of motor blockade was similar between groups: 168.83±9.71 versus 170.83±9.48 minutes (p=0.42).

Discussion

The principal finding of this analysis was that both combinations produced comparable sensory block characteristics. Although sensory blockade occurred approximately 46 seconds earlier with fentanyl, the difference was not statistically significant. Similarly, the duration and highest cephalad level of sensory blockade were comparable.

In the present study, the mean onset of sensory blockade to T10 was 4.63±1.10 minutes in the bupivacaine-fentanyl (BUF) group and 5.40±1.38 minutes in the bupivacaine-nalbuphine (BUN) group, with no statistically significant difference (p=0.21). Thus, although sensory blockade appeared approximately 46 seconds earlier with fentanyl, this difference was not clinically or statistically significant. The similarity in onset suggests that, at the doses used in the present study, addition of either fentanyl or nalbuphine to hyperbaric bupivacaine does not substantially alter the initial establishment of sensory spinal anaesthesia.[8]

The present observation is consistent with the findings of Shagufta Naaz et al.,[10] who compared hyperbaric bupivacaine with fentanyl and nalbuphine in lower limb orthopaedic surgery. Although the onset of sensory blockade was somewhat faster in the fentanyl group, the difference was not statistically significant. Similarly, Hala Mostafa Gomaa et al.**[9]**, in patients undergoing caesarean section, reported no significant difference in the onset of sensory blockade between bupivacaine-fentanyl and bupivacaine-nalbuphine combinations.

The maximum cephalad sensory level was also comparable between the two groups. T6 was the most frequently achieved sensory level, occurring in 53.3% of patients in the BUF group and 46.7% in the BUN group. The overall distribution of sensory levels from T4 to T8 did not differ significantly between the groups (p=0.843).

The mean duration of sensory blockade in the present study was approximately 156.83±10.70 minutes in the BUF group and 159.33±12.01 minutes in the BUN group. The difference was not statistically significant. Thus, although nalbuphine demonstrated a numerical tendency toward slightly longer sensory blockade, the magnitude of difference was small and did not establish superiority of either drug with respect to sensory block duration.

Similarly, Tiwari and Tomar reported prolongation of two-segment sensory regression with intrathecal nalbuphine, particularly at a dose of 400 µg.[4] However, the results of the present study suggest that the 1 mg dose of nalbuphine used in combination with 15 mg hyperbaric bupivacaine did not produce a statistically significant prolongation of clinically assessed sensory blockade compared with fentanyl.

Conclusion

Intrathecal nalbuphine 1 mg and fentanyl 25 µg, when combined with 15 mg hyperbaric bupivacaine, produced comparable sensory blockade with similar duration and maximum sensory level.

Fentanyl resulted in a significantly faster onset of motor blockade, but the duration of motor blockade was comparable. Thus, nalbuphine provides a sensory and motor block profile broadly comparable to fentanyl while offering the additional analgesic advantage demonstrated in the parent study.

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