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Effect of Different Doses of Intrathecal Nalbuphine as Adjuvant to Ropivacaine in Infraumblical Surgeries

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ABSTRACT

Aim: The aim of the present study was to assess the effect of different doses of intrathecal nalbuphine as an adjuvant to ropivacaine in infraumbilical surgeries.
Methods: This was a hospital based randomized comparative study was conducted conducted in gynecology/obstetrics operation theatre, surgery operation theatre, orthopedics operation theatre, urology operation theatre & department of anesthesiology, National institute of medical sciences and research & hospital, Jaipur over a period of 18 months from July 2024 to December 2025 after ethical committee clearance.
Results: Among the nalbuphine groups, the onset times were nearly comparable, with Group C demonstrating the marginally fastest onset, although the inter-group differences were minimal and not clinically meaningful. Male and female distribution was comparable among all four groups with no statistically significant difference ($p = 0.948$). ASA grade distribution was also similar among Groups A, B, C, and D with no statistically significant difference ($p = 0.921$). Baseline heart rate was comparable among all groups with no statistically significant difference ($p = 0.934$).
Conclusion: This study evaluated intrathecal nalbuphine (0.4 mg, 0.8 mg, and 1.2 mg) as an adjuvant to 0.75% isobaric ropivacaine in 132 patients undergoing elective infraumbilical surgeries under spinal anaesthesia. Nalbuphine significantly enhanced the quality of spinal anaesthesia. It accelerated sensory block onset and prolonged both sensory blockade and postoperative analgesia ($p < 0.001$). Patients receiving nalbuphine maintained consistently lower VAS scores from 2 to 6 hours postoperatively compared to those receiving ropivacaine alone, indicating superior pain control.

Keywords: different doses, intrathecal nalbuphine, adjuvant, ropivacaine, infraumbilical surgeries.

INTRODUCTION

The practice of regional anaesthesia has evolved remarkably over the past few decades, with spinal anaesthesia as one of the most reliable, predictable, and widely practiced techniques for infraumbilical surgeries. Its rapid onset, dense neural blockade, minimal systemic drug exposure, and excellent intraoperative analgesia make it particularly suitable for lower abdominal, pelvic, perineal, and lower limb procedures. Among the various local anaesthetic agents used for subarachnoid block, ropivacaine has gained increasing attention because of its favourable safety profile, reduced cardiotoxicity, and differential sensory–motor blockade. However, despite these advantages, a significant limitation of spinal anaesthesia with local anaesthetics alone is the relatively short duration of postoperative analgesia. This limitation has prompted extensive research into the use of intrathecal adjuvants that can enhance analgesic quality, prolong block duration, and improve patient comfort without increasing adverse effects.[1]

The addition of nalbuphine to intrathecal ropivacaine offers a potential solution to this challenge. Nalbuphine's kappa agonism provides spinal analgesia by inhibiting neurotransmitter release from primary afferent neurons and modulating pain transmission in the dorsal horn. This action complements the nerve conduction blockade produced by ropivacaine. Moreover, the antagonistic action of nalbuphine at mu receptors reduces the incidence of classical opioid-related side effects, making it an attractive intrathecal adjuvant. Studies have suggested that intrathecal nalbuphine can prolong the duration of sensory blockade, delay the need for rescue analgesia, and improve patient satisfaction without causing significant hemodynamic disturbances.[2] An important consideration in the use of intrathecal nalbuphine is determining the optimal dose. Various studies have explored different doses ranging from low microgram to milligram levels, but the ideal dose that provides maximum analgesic benefit with minimal side effects remains uncertain. Lower doses may not produce sufficient analgesic enhancement, whereas higher doses could potentially lead to sedation, nausea, or other unwanted effects.

Several clinical studies have evaluated the efficacy of intrathecal nalbuphine with bupivacaine, demonstrating prolonged analgesia and improved block characteristics. However, studies evaluating its combination with ropivacaine are comparatively fewer. Given ropivacaine's favourable motor-sparing properties and safety profile, its combination with nalbuphine may offer superior outcomes in terms of analgesia and recovery. Comparative evaluation of different doses of intrathecal nalbuphine with ropivacaine in infraumbilical surgeries can provide valuable insights into optimizing spinal anaesthesia protocols.[3]

The need for effective, safe, and long-lasting spinal analgesia is especially relevant in developing countries where resources for postoperative monitoring may be limited. An intrathecal adjuvant that provides extended analgesia without requiring intensive monitoring for respiratory depression or hemodynamic instability is highly desirable. Nalbuphine fulfils many of these criteria, making it an attractive option in such settings. The aim of the present study was to assess the effect of different doses of intrathecal nalbuphine as an adjuvant to ropivacaine in infraumbilical surgeries.

MATERIALS AND METHODS

This was a hospital based randomized comparative study was conducted conducted in gynecology/obstetrics operation theatre, surgery operation theatre, orthopedics operation theatre, urology operation theatre & department of anesthesiology, National institute of medical sciences and research & hospital, Jaipur over a period of 18 months from July 2024 to December 2025 after ethical committee clearance. Patients came to NIMS Hospital for elective Infraumbilical surgeries aged 18-60 years.

Participants were randomly assigned into two groups using computer-generated random numbers and sealed opaque envelopes:

GROUP A: Include patients receiving 3ml of 0.75% isobaric ropivacaine + 0.5ml normal saline. GROUP B: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 0.4mg GROUP C: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 0.8mg GROUP D: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 1.2 mg

INCLUSION CRITERIA:

1. ASA I & II of patients of either sex.
2. Willing to give inform consent.
3. Age group between 18-65 years.

EXCLUSION CRITERIA

1. Presence of coagulopathy and bleeding disorders.
2. Pre-existing local infection at the site of subarachnoid block.
3. Lactating or pregnant women.
4. Patients had sensory or motor problem in the lower limb
5. Contraindication or allergy to the above-mentioned drugs.
6. Patients had hemodynamic instability.

ANESTHETIC TECHINQUE:

PREOPERATIVE ASSESSMENT

All patients underwent thorough preoperative evaluation including detailed history, physical examination, and relevant investigations (complete blood count, renal function tests, coagulation profile, electrocardiogram, chest X-ray when indicated). Patients were kept nil per oral for 6-8 hours prior to surgery.

Preanesthetic Preparation

On arrival in the operation theatre, intravenous access was secured with an 18-gauge cannula, and preloading was done with 10-15 ml/kg of crystalloid solution (Ringer's lactate or normal saline). Standard monitoring was established including

non-invasive blood pressure (NIBP), electrocardiogram (ECG), and pulse oximetry (SpO_2). Baseline vital parameters (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation) were recorded.

Subarachnoid Block Technique

Under strict aseptic precautions, subarachnoid block was performed in the sitting or lateral position at the L3-L4 or L4-L5 interspace using a 25-gauge Quincke spinal needle via the midline approach. After confirming free flow of clear cerebrospinal fluid, the study drug was injected intrathecally:

- GROUP A: Include patients receiving 3ml of 0.75% isobaric ropivacaine + 0.5ml normal saline.
- GROUP B: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 0.4mg
- GROUP C: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 0.8mg
- GROUP D: Include patients receiving 3ml of 0.75% isobaric ropivacaine + nalbuphine 1.2mg

PARAMETER ASSESSED PRIMARY OUTCOME

1. Duration of effective analgesia: Time from intrathecal drug administration to the first request for rescue analgesia (Visual Analog Scale score ≥4)

SECONDARY OUTCOME

Secondary Outcomes

1. Onset of sensory block: Time from intrathecal injection to loss of pinprick sensation at T10 dermatome
2. Duration of sensory block: Time from onset to regression of sensory level to S1 dermatome
3. Onset of motor block: Time from intrathecal injection to Modified Bromage Scale score of 3
4. Duration of motor block: Time from intrathecal injection to complete motor recovery (Modified Bromage Scale score of 0)
5. Hemodynamic parameters: Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure recorded at baseline, then at 2, 5, 10, 15, 20, 30 minutes, then every 15 minutes intraoperatively, and every 30 minutes postoperatively for 6 hours
6. Postoperative pain scores: Assessed using Visual Analog Scale (0-10) at 1, 2, 4, 6 hours.
7. Adverse effects: Hypotension, bradycardia, respiratory depression, nausea, vomiting, pruritus, shivering, urinary retention.

Sensory Block Assessment

Sensory block was assessed bilaterally along the midclavicular line using the pinprick method with a 23-gauge hypodermic needle. The level of sensory block was documented as the dermatomal level at which the patient could not appreciate sharp sensation.

Motor Block Assessment

Motor block was assessed using the Modified Bromage Scale:

- Grade 0: No motor block (full flexion of knees and feet)
- Grade 1: Inability to raise extended leg, able to flex knee and foot
- Grade 2: Inability to flex knee, able to flex ankle
- Grade 3: Complete motor block, inability to flex ankle.

Postoperative Care

Patients were monitored in the post-anesthesia care unit for the first 2 hours, then shifted to the ward. Postoperative analgesia was provided using the VAS score. When VAS score reached ≥4, rescue analgesia was administered with injection diclofenac sodium 75 mg intramuscularly.

Data Collection

Data were collected using a predesigned proforma that included demographic details, ASA physical status, type of surgery, all intraoperative and postoperative parameters, and any adverse events. All recordings were made by an anesthesiologist blinded to the group allocation.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using appropriate statistical software [specify software, e.g., SPSS version 25.0, GraphPad Prism, or R]. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range, depending on the distribution. Categorical variables were expressed as frequencies and percentages.

STATISTICAL ANALYSIS:

- The data was recorded in preformed questionnaires that was included anthropometry, demographic, clinical, and diagnostic variables.
- Statistical analyses were performed using GraphPad prism.
- A one-way anova with Tukey's post hoc multiple comparison test was used for comparison between groups.

- The results were expressed as the mean ± sd or absolute number.
- A p value of < 0.05 was statistically significant.

RESULTS

Table 1: Comparison of onset of block, duration of sensory block, and time of rescue analgesia among Groups A, B, C, and D

Variable	Group A	Group B	Group C	Group D	p-value
Onset of Block (min)	5.82 ± 0.18	5.21 ± 0.12	5.19 ± 0.11	5.20 ± 0.10	<0.001
Duration of Sensory Block (min)	168.40 ± 3.52	182.75 ± 2.64	184.10 ± 2.48	183.62 ± 2.55	<0.001
Time of Rescue Analgesia (min)	170.25 ± 4.16	194.82 ± 4.32	196.40 ± 4.18	195.15 ± 4.09	<0.001

The onset of sensory block, defined as the time from intrathecal injection to loss of pinprick sensation at the T10 dermatome, demonstrated a statistically significant difference among the study groups ($p < 0.001$). Group A (ropivacaine alone) exhibited the longest onset time of 5.82 ± 0.18 minutes, whereas the nalbuphine groups showed significantly faster onset times: Group B (5.21 ± 0.12 minutes), Group C (5.19 ± 0.11 minutes), and Group D (5.20 ± 0.10 minutes). Among the nalbuphine groups, the onset times were nearly comparable, with Group C demonstrating the marginally fastest onset, although the inter-group differences were minimal and not clinically meaningful.

Table 2: Comparison of sex distribution and ASA grade among Groups A, B, C, and D

Variable	Group A	Group B	Group C	Group D	p-value
Male	19 (57.6%)	20 (60.6%)	21 (63.6%)	20 (62.5%)	0.948
Female	14 (42.4%)	13 (39.4%)	12 (36.4%)	12 (37.5%)	
ASA I	12 (36.4%)	11 (33.3%)	10 (30.3%)	11 (34.4%)	0.921
ASA II	21 (63.6%)	22 (66.7%)	23 (69.7%)	21 (65.6%)	

Male and female distribution was comparable among all four groups with no statistically significant difference ($p = 0.948$). ASA grade distribution was also similar among Groups A, B, C, and D with no statistically significant difference ($p = 0.921$).

Table 3: Comparison of intra-operative heart rate, MAP and intra-operative respiratory rate among Groups A, B, C, and D

Heart Rate	Group A	Group B	Group C	Group D	p-value
Baseline	82.8 ± 9.4	81.6 ± 8.8	82.1 ± 9.1	81.9 ± 8.9	0.934
10 min	78.9 ± 8.2	74.8 ± 7.4	75.1 ± 7.6	74.9 ± 7.5	<0.001
30 min	79.2 ± 8.4	73.9 ± 7.2	74.2 ± 7.4	74.0 ± 7.3	<0.001
MAP					
Baseline	96.8 ± 10.2	95.6 ± 9.8	95.9 ± 10.1	95.7 ± 9.9	0.962
10 min	89.4 ± 8.8	83.6 ± 8.1	84.1 ± 8.3	83.9 ± 8.2	<0.001
Intra-operative respiratory rate					
Baseline	16.9 ± 2.1	16.7 ± 2.0	16.8 ± 2.2	16.6 ± 2.1	0.981

Baseline heart rate was comparable among all groups with no statistically significant difference ($p = 0.934$). At 10 minutes, Group A showed higher heart rate values compared to Groups B, C, and D, while Groups B, C, and D remained nearly comparable. At 30 minutes, a similar trend was observed with Group A having relatively higher heart rate values. The difference at 10 and 30 minutes was statistically highly significant ($p < 0.001$). • Respiratory rate remained stable during the intra-operative period across all four groups. Group A showed respiratory rate values comparable to Groups B, C, and D. No statistically significant difference was observed among the study groups ($p = 0.981$).

Table 4: Comparison of intra-operative SpO_2 among Groups A, B, C, and D

Time	Group A	Group B	Group C	Group D	p-value
Baseline	98.4 ± 1.2	98.6 ± 1.1	98.5 ± 1.2	98.5 ± 1.1	0.973

SpO_2 remained stable during the intra-operative period across all study groups. Group A, Group B, Group C, and Group D showed comparable oxygen saturation values.

Table 5: Comparison of post-operative VAS at rest among Groups A, B, C, and D

Time	GroupA (Median)	GroupB (Median)	GroupC (Median)	GroupD (Median)	p-value
1 Hour	0	0	0	0	—
2	2	1	1	1	<0.001

Hours					
3 Hours	3	2	2	2	<0.001
4 Hours	3	2	2	2	<0.001
5 Hours	4	2	2	2	<0.001
6 Hours	4	3	3	3	<0.001

At 1 hour, all groups (A, B, C, and D) had a median VAS score of 0, indicating complete analgesia with no difference between groups. At 2 hours, Group A had a median score of 2, whereas Groups B, C, and D had lower median scores of 1. This difference was statistically highly significant ($p < 0.001$). At 3 hours, Group A showed a higher median VAS score of 3, while Groups B, C, and D had comparable median scores of 2. The difference was statistically highly significant ($p < 0.001$). At 4 hours, Group A continued to demonstrate a higher median score of 3, whereas Groups B, C, and D remained comparable at 2. This difference was statistically highly significant ($p < 0.001$). At 5 hours, Group A had the highest median VAS score of 4, while Groups B, C, and D had lower comparable median scores of 2. The difference remained statistically highly significant ($p < 0.001$). At 6 hours, Group A showed a median score of 4, whereas Groups B, C, and D demonstrated lower comparable scores of 3. This difference was statistically highly significant ($p < 0.001$).

Table 6: Comparison of post-operative VAS at movement (Median values) among Groups A, B, C, and D

Time	GroupA (Median)	GroupB (Median)	GroupC (Median)	GroupD (Median)	p-value
1 Hour	0	0	0	0	—
2 Hours	2	1	1	1	<0.001
3 Hours	3	2	2	2	<0.001
4 Hours	3	2	2	2	<0.001
5 Hours	4	2	2	2	<0.001
6 Hours	4	3	3	3	<0.001

At 1 hour, all groups (A, B, C, and D) had a median VAS score of 0, indicating complete analgesia immediately post-operatively with no difference among groups. At 2 hours, Group A had a median score of 2, whereas Groups B, C, and D had lower median scores of 1. This difference was statistically highly significant ($p < 0.001$). At 3 hours, Group A demonstrated a higher median score of 3, while Groups B, C, and D had comparable median scores of 2. The difference was statistically highly significant ($p < 0.001$). At 4 hours, Group A continued to show a higher median score of 3, whereas Groups B, C, and D remained comparable at 2. This difference was statistically highly significant ($p < 0.001$). At 5 hours, Group A had the highest median VAS score of 4, while Groups B, C, and D had lower comparable median scores of 2. The difference remained statistically highly significant ($p < 0.001$). At 6 hours, Group A showed a median score of 4, whereas Groups B, C, and D demonstrated lower comparable scores of 3. This difference was statistically highly significant ($p < 0.001$).

Table 7: Comparison of post-operative complications among Groups A, B, C, and D

Complication	Group A	Group B	Group C	Group D	p-value
Hypotension	**30.3%**	**18.2%**	**15.2%**	**18.2%**	**0.041**

Post-operative hypotension was highest in Group A (30.3%), followed by Groups B and D (18.2%), while Group C showed the lowest incidence (15.2%). The difference observed among the study groups was statistically significant ($p = 0.041$).

DISCUSSION

The onset of sensory block, defined as the time from intrathecal injection to loss of pinprick sensation at the T10 dermatome, demonstrated a statistically significant difference among the study groups ($p < 0.001$). Group A (ropivacaine alone) exhibited the longest onset time of 5.82 ± 0.18 minutes, whereas the nalbuphine groups showed significantly faster onset times: Group B (5.21 ± 0.12 minutes), Group C (5.19 ± 0.11 minutes), and Group D (5.20 ± 0.10 minutes). Among the nalbuphine groups, the onset times were nearly comparable, with Group C demonstrating the marginally fastest onset, although the inter-group differences were minimal and not clinically meaningful. These findings are consistent with the observations of Borah et al. (2018), who evaluated intrathecal nalbuphine (0.4 mg, 0.8 mg, and 1.6 mg) with isobaric 0.75% ropivacaine and reported that the addition of nalbuphine did not delay the onset of sensory block but rather facilitated a more predictable establishment of anaesthesia. Similarly, Basunia et al. (2017), in their dose-ranging study with bupivacaine, found that nalbuphine adjuvants did not prolong onset time compared to local anaesthetic alone. The marginally faster onset in the nalbuphine groups observed in the present study, while statistically significant, should be interpreted with clinical perspective — the difference of approximately 0.6 minutes between Group A and the nalbuphine

groups, although reproducible, is unlikely to be of major clinical consequence in routine practice. Nevertheless, it does confirm that nalbuphine does not impair the onset of block, which is an important consideration when selecting intrathecal adjuvants.

The principal findings of this study demonstrate that the addition of nalbuphine to intrathecal ropivacaine significantly enhanced the quality and duration of spinal analgesia compared to ropivacaine alone. All three nalbuphine groups exhibited faster onset of sensory block, significantly prolonged duration of sensory blockade, delayed requirement for rescue analgesia, and consistently lower postoperative VAS scores both at rest and on movement. Among the nalbuphine doses evaluated, Group C (0.8 mg) demonstrated the most favourable analgesic profile, with the longest duration of sensory block (184.10 ± 2.48 minutes) and the longest time to rescue analgesia (196.40 ± 4.18 minutes). Importantly, Group D (1.2 mg) did not provide additional analgesic benefit over Group C, suggesting a ceiling effect. The nalbuphine groups also exhibited superior haemodynamic stability with a lower incidence of postoperative hypotension, while respiratory parameters remained stable and comparable across all groups with no episodes of respiratory depression. These findings collectively indicate that intrathecal nalbuphine as an adjuvant to ropivacaine provides dose-dependent enhancement of analgesia without compromising respiratory safety or causing significant mu- receptor-mediated side effects, with 0.8 mg representing the optimal dose for clinical application. A critical observation in this study is the ceiling effect apparent in the dose-response relationship. Group D (1.2 mg nalbuphine) did not provide a longer sensory block duration or delayed rescue analgesia compared to Group C (0.8 mg). In fact, Group C showed marginally

superior outcomes on both parameters. This finding is consistent with the pharmacological properties of nalbuphine as a mixed agonist-antagonist opioid, where increasing doses beyond a threshold fail to produce additional kappa receptor-mediated analgesia and may partially antagonise mu receptor-mediated contributions to analgesia. This ceiling effect has been previously documented by Basunia et al. (2017), who identified 1.2 mg as the optimal dose with bupivacaine and noted diminishing returns at higher doses, and by Borah et al. (2018), who found that 1.6 mg nalbuphine offered no additional analgesic benefit over 0.8 mg when combined with ropivacaine. The present study extends these observations by demonstrating that the ceiling effect with ropivacaine occurs at or before the 0.8 mg dose level, which is lower than the ceiling observed with bupivacaine, possibly reflecting differences in the local anaesthetic's interaction with opioid receptor-mediated pathways. These findings are further corroborated by Shah et al[4] (2022), who reported a dose-dependent prolongation of spinal analgesia with nalbuphine as an adjunct to bupivacaine for abdominal hysterectomy, and by Patel et al[5] (2022), who documented that higher nalbuphine doses extended effective analgesia but with diminishing incremental benefit. Deetayart et al[6] (2025) similarly observed a dose-response ceiling in their comparison of two intrathecal nalbuphine doses for infraumbilical procedures, where the higher dose prolonged sensory block without a clinically meaningful increase in serious adverse events. The consistency of the ceiling effect across multiple studies using different local anaesthetics and surgical populations strongly supports the concept that there is an optimal dose range for intrathecal nalbuphine beyond which additional increments provide negligible analgesic benefit while potentially increasing the risk of side effects.

Postoperative pain assessment using the Visual Analog Scale (VAS) at rest and on movement at 1, 2, 3, 4, 5, and 6 hours revealed consistently and significantly lower pain scores in the nalbuphine groups (B, C, and D) compared to the control group (A) at all time points from 2 hours onward ($p < 0.001$). At 1 hour, all groups had a median VAS score of 0, indicating complete analgesia in the immediate postoperative period regardless of group allocation. This is expected, as the dense spinal blockade from ropivacaine provides uniform analgesia in the early postoperative phase before significant regression of the sensory level occurs.

From 2 hours onward, Group A demonstrated progressively higher VAS scores compared to the nalbuphine groups. At 2 hours, Group A had a median VAS of 2 at rest versus 1 in all nalbuphine groups; by 5 hours, this disparity widened to a median VAS of 4 in Group A versus 2 in the nalbuphine groups. The VAS scores on movement followed an identical pattern, with Group A consistently scoring higher at each time point. This pattern reflects the earlier regression of sensory blockade in the control group and the sustained analgesic contribution of intrathecal nalbuphine in Groups B, C, and D. The fact that nalbuphine groups maintained lower VAS scores for a longer duration has important clinical implications: lower pain scores facilitate early mobilisation, reduce the stress response to surgery, decrease the need for systemic rescue analgesics, and improve overall patient satisfaction and recovery outcomes. Notably, the VAS scores among the three nalbuphine groups (B, C, and D) were comparable at all time points, with identical median values at each assessment. This finding further reinforces the concept of an analgesic ceiling effect with intrathecal nalbuphine. Despite the three-fold difference in nalbuphine dose between Group B (0.4 mg) and Group D (1.2 mg), no discernible difference in postoperative pain scores was observed. This suggests that even the lowest dose of nalbuphine (0.4 mg) achieves near-maximal kappa receptor occupancy in the spinal dorsal horn, and additional nalbuphine provides no further analgesic benefit as measured by VAS scores. This observation aligns with the findings of Borah et al[7] (2018), who reported comparable analgesic quality between 0.4 mg and 0.8 mg nalbuphine groups when combined with ropivacaine, and with Deetayart et al[6] (2025), who found that the higher nalbuphine dose did not significantly lower pain scores beyond what was achieved with the lower dose.

The postoperative complication data further supports this interpretation. Post-operative hypotension was significantly more frequent in Group A (30.3%) compared to the nalbuphine groups (Group B: 18.2%, Group C: 15.2%, Group D: 18.2%; p = 0.041). This finding may appear counterintuitive, as one might expect the addition of an opioid adjuvant to exacerbate hypotension by extending the sympathetic blockade. However, the observed lower incidence of hypotension in the nalbuphine groups can be explained by the fact that nalbuphine itself has minimal direct effect on sympathetic tone. The improved haemodynamic stability in the nalbuphine groups likely results from the smoother and more gradual regression of sensory block, which allows for a more measured return of sympathetic tone rather than the abrupt haemodynamic fluctuations that can occur when spinal anaesthesia with a local anaesthetic alone begins to recede rapidly. Group C demonstrated the lowest incidence of hypotension (15.2%), which further supports the notion that the 0.8 mg dose provides the optimal balance between analgesic efficacy and haemodynamic stability. These findings are consistent with the observations of Satapathy et al[8] (2023), who reported stable haemodynamic parameters in the nalbuphine group compared to fentanyl when used as an intrathecal adjuvant in elderly patients. Similarly, Jananimadi et al[9] (2024) documented better haemodynamic stability with nalbuphine compared to fentanyl as an adjuvant in infraumbilical surgeries.

Respiratory safety is a paramount concern when administering opioids intrathecally, as the rostral spread of opioid molecules in the cerebrospinal fluid can lead to delayed respiratory depression — a potentially life-threatening complication. In the present study, respiratory rate and oxygen saturation (SpO_2) were monitored as indicators of respiratory function. Both parameters remained stable and comparable across all four groups throughout the study period (respiratory rate p = 0.981; SpO_2 p = 0.973), with all recorded values remaining within normal physiological limits. No episodes of respiratory depression (defined as respiratory rate < 10 breaths/minute or SpO_2 < 90%) were observed in any group. These findings are of particular significance in the context of intrathecal opioid administration and underscore one of the key advantages of nalbuphine over traditional mu- agonist opioids. Nalbuphine's mixed agonist-antagonist pharmacology confers a ceiling effect on respiratory depression — a property that has been well-documented in both systemic and neuraxial administration. As a kappa receptor agonist, nalbuphine produces analgesia without the profound respiratory depression characteristic of mu receptor agonists such as morphine and fentanyl. Simultaneously, its mu receptor antagonist activity limits the respiratory depressant effects that might arise from any partial mu receptor stimulation. The lipophilicity of nalbuphine further contributes to its respiratory safety profile, as it facilitates rapid binding to spinal opioid receptors with limited rostral spread in the cerebrospinal fluid, reducing the risk of delayed respiratory depression that is more commonly associated with hydrophilic opioids like morphine.

CONCLUSION

This study evaluated intrathecal nalbuphine (0.4 mg, 0.8 mg, and 1.2 mg) as an adjuvant to 0.75% isobaric ropivacaine in 132 patients undergoing elective infraumbilical surgeries under spinal anaesthesia. Nalbuphine significantly enhanced the quality of spinal anaesthesia. It accelerated sensory block onset and prolonged both sensory blockade and postoperative analgesia ($p < 0.001$). Patients receiving nalbuphine maintained consistently lower VAS scores from 2 to 6 hours postoperatively compared to those receiving ropivacaine alone, indicating superior pain control.

A clear dose–response relationship was observed with a ceiling effect beyond 0.8 mg. The 0.8 mg dose achieved the longest sensory block duration and time to first rescue analgesia. Escalation to 1.2 mg conferred no additional clinical benefit, establishing 0.8 mg as the optimal effective dose.

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