



Original Article

Effect of Intrathecal Fentanyl as an Adjuvant to Isobaric Ropivacaine on Sensory and Motor Block Characteristics During Subarachnoid Anaesthesia for Lower Abdominal and Lower Extremity Surgeries: A Randomized Comparative Study

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ABSTRACT

Background: Intrathecal adjuvants are commonly added to local anaesthetics during spinal anaesthesia to enhance the quality and duration of sensory blockade while providing prolonged postoperative analgesia. Fentanyl, a lipophilic opioid, has been shown to improve spinal anaesthesia when combined with local anaesthetics such as ropivacaine.

Objective: To evaluate the effect of intrathecal fentanyl as an adjuvant to 0.75% isobaric ropivacaine on sensory and motor block characteristics during subarachnoid anaesthesia for lower abdominal and lower extremity surgeries.

Materials and Methods: This prospective, randomized, single-blind comparative study included 60 ASA physical status I and II patients aged 30–60 years undergoing elective lower abdominal and lower extremity surgeries under spinal anaesthesia. Patients were randomly allocated into two groups (n = 30 each). Group R received 3 mL of 0.75% isobaric ropivacaine (22.5 mg) with 0.5 mL normal saline, while Group RF received 3 mL of 0.75% isobaric ropivacaine combined with fentanyl 25 µg (0.5 mL). The onset of sensory and motor block, time to T10 sensory level, duration of motor block, and two-segment sensory regression time were assessed. Statistical analysis was performed using the independent Student's *t*-test and Chi-square test, with $p < 0.05$ considered statistically significant.

Results: Baseline demographic characteristics were comparable between the two groups ($p > 0.05$). The onset of sensory block (4.78 ± 0.47 vs 4.69 ± 0.42 min; $p = 0.63$), time to T10 sensory block (7.04 ± 0.47 vs 6.91 ± 0.33 min; $p = 0.24$), and onset of motor block (5.19 ± 0.64 vs 5.42 ± 0.65 min; $p = 0.18$) were similar between Groups R and RF, respectively. However, the duration of motor block was significantly longer in Group RF (192.6 ± 7.36 vs 187.2 ± 7.89 min; $p = 0.009$). Two-segment sensory regression time was markedly prolonged in the fentanyl group (336.7 ± 8.8 vs 236.4 ± 17.8 min; $p < 0.0001$).

Conclusion: The addition of 25 µg intrathecal fentanyl to 0.75% isobaric ropivacaine significantly prolonged sensory blockade and postoperative analgesia, with a modest increase in motor block duration, without affecting the onset of sensory or motor blockade. The combination is a safe and effective option for improving the quality of spinal anaesthesia in lower abdominal and lower extremity surgeries.

Keywords: Subarachnoid anaesthesia, Isobaric ropivacaine, Intrathecal fentanyl, Sensory block; Motor block, Postoperative analgesia, Spinal anaesthesia.

INTRODUCTION

Subarachnoid (spinal) anaesthesia is one of the most commonly employed regional anaesthetic techniques for lower abdominal and lower extremity surgeries because of its rapid onset, profound sensory and motor blockade, excellent muscle relaxation, and reduced perioperative morbidity compared with general anaesthesia. It provides superior intraoperative analgesia while allowing patients to remain awake, minimizing airway manipulation and facilitating early postoperative recovery. Despite these advantages, the relatively short duration of spinal anaesthesia with local anaesthetics alone may be insufficient for prolonged surgical procedures and effective postoperative pain management, necessitating the use of intrathecal adjuvants to enhance block characteristics and prolong analgesia [1].

Bupivacaine has traditionally been the most widely used local anaesthetic for spinal anaesthesia. However, concerns regarding its cardiotoxicity and prolonged motor blockade have prompted increasing interest in ropivacaine as a safer alternative. Ropivacaine is a long-acting amino-amide local anaesthetic with lower lipid solubility and reduced potential for central nervous system and cardiovascular toxicity compared with bupivacaine. It also exhibits greater sensory-motor differentiation, producing effective sensory blockade with comparatively less intense and shorter-duration motor blockade, thereby facilitating earlier ambulation and recovery [2–4].

Isobaric ropivacaine has gained popularity for spinal anaesthesia because it provides reliable surgical anaesthesia while maintaining favourable haemodynamic stability. However, when administered alone, its duration of postoperative analgesia may be limited, especially during longer procedures. To overcome this limitation, several intrathecal adjuvants have been investigated to improve the quality and duration of spinal blockade without significantly increasing adverse effects [5].

Among these adjuvants, fentanyl is one of the most extensively studied lipophilic opioids. Intrathecal fentanyl acts primarily on μ -opioid receptors located in the substantia gelatinosa of the spinal cord, producing synergistic analgesia when combined with local anaesthetics. Due to its high lipid solubility, fentanyl has a rapid onset of action, enhances intraoperative analgesia, prolongs sensory blockade, reduces postoperative analgesic requirements, and has a relatively low incidence of delayed respiratory depression compared with hydrophilic opioids such as morphine [6–8].

Several randomized clinical trials have demonstrated that adding fentanyl to intrathecal local anaesthetics improves the quality of spinal anaesthesia by prolonging sensory block and postoperative analgesia while exerting minimal influence on haemodynamic parameters. Although a modest prolongation of motor blockade may occur, recovery remains clinically acceptable. These benefits make fentanyl an attractive adjuvant for lower abdominal and lower limb surgeries requiring reliable anaesthesia and extended postoperative pain relief [9–12].

Nevertheless, the magnitude of benefit obtained by combining fentanyl with isobaric ropivacaine varies among published studies owing to differences in drug concentrations, patient populations, and surgical procedures. Additional evidence is therefore required to optimize spinal anaesthetic regimens and establish the efficacy of this combination in routine clinical practice.

Hence, the present randomized comparative study was undertaken to evaluate the effect of intrathecal fentanyl (25 μ g) as an adjuvant to 0.75% isobaric ropivacaine on the onset and duration of sensory and motor blockade in patients undergoing elective lower abdominal and lower extremity surgeries under subarachnoid anaesthesia.

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomized, single-blind comparative study was conducted in the Department of Anaesthesiology after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment. The study included 60 adult patients scheduled for elective lower abdominal and lower extremity surgeries under subarachnoid anaesthesia.

Study Population

Sixty patients belonging to American Society of Anesthesiologists (ASA) physical status I and II, aged between 30 and 60 years, were randomly allocated into two equal groups ($n = 30$ each).

- **Group R:** Received 3 mL of 0.75% isobaric ropivacaine (22.5 mg) with 0.5 mL normal saline.
- **Group RF:** Received 3 mL of 0.75% isobaric ropivacaine (22.5 mg) combined with fentanyl 25 μ g (0.5 mL).

Randomization was performed using a computer-generated random number table.

Inclusion Criteria

- ASA physical status I and II.
- Age between 30 and 60 years.
- Body weight between 50 and 80 kg.

- Patients undergoing elective lower abdominal or lower extremity surgeries under spinal anaesthesia.

Exclusion Criteria

- ASA physical status III and IV.
- Age below 30 years or above 60 years.
- Body weight less than 50 kg or greater than 80 kg.
- Coagulation disorders.
- Local infection at puncture site.
- Vertebral deformity.
- Known hypersensitivity to study drugs.
- History of chronic opioid use or substance abuse.

Anaesthetic Technique

All patients underwent routine pre-anaesthetic evaluation one day before surgery. Patients were kept nil per oral for six hours before surgery.

An intravenous line was secured using an 18-G cannula, and preloading was performed with Ringer's lactate solution (10–15 mL/kg). Premedication consisted of glycopyrrolate 0.2 mg, ondansetron 4 mg, and midazolam 1 mg administered intravenously.

Standard monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry, and heart rate. Under strict aseptic precautions, spinal anaesthesia was administered in the left lateral position using a 25-G Quincke spinal needle at the L3–L4 interspace. Following confirmation of free cerebrospinal fluid flow, the allocated intrathecal drug was injected slowly. Patients were immediately positioned supine.

Outcome Measures

The following parameters were evaluated:

- Time to onset of sensory block.
- Time to achieve T10 sensory block.
- Highest sensory level achieved.
- Onset of motor block assessed using the Modified Bromage Scale.
- Duration of motor block.
- Two-segment sensory regression time.

Statistical Analysis

Data were analysed using SPSS software. Continuous variables were expressed as mean $\pm$ standard deviation and compared using the independent Student's t-test. Categorical variables were analysed using the Chi-square test. A p-value <0.05 was considered statistically significant.

RESULT AND OBSERVATIONS;

Table 1. Baseline Demographic Characteristics of the Study Participants

Variable	Group R (n = 30)	Group RF (n = 30)	p-value
Age (years), Mean $\pm$ SD	26.6 $\pm$ 9.3	26.9 $\pm$ 7.8	0.892
Weight (kg), Mean $\pm$ SD	51.1 $\pm$ 4.58	53.1 $\pm$ 6.17	0.159
Male, n (%)	13 (43.3)	14 (46.7)	0.795
Female, n (%)	17 (56.7)	16 (53.3)	

Table 2. Comparison of Onset Time of Sensory Block Between the Study Groups

Parameter	Group R (n = 30)	Group RF (n = 30)	p-value
Onset of sensory block (min), Mean $\pm$ SD	4.78 $\pm$ 0.47	4.69 $\pm$ 0.42	0.63

Table 3. Comparison of Time to Peak Sensory Block (T10 Dermatome)

Parameter	Group R (n = 30)	Group RF (n = 30)	p-value
Time to T10 sensory block (min), Mean $\pm$ SD	7.04 $\pm$ 0.47	6.91 $\pm$ 0.33	0.24

Table 4. Comparison of Onset Time of Motor Block

Parameter	Group R (n = 30)	Group RF (n = 30)	p-value
Onset of motor block (min), Mean $\pm$ SD	5.19 $\pm$ 0.64	5.42 $\pm$ 0.65	0.18

Table 5. Comparison of Duration of Motor Block

Parameter	Group R (n = 30)	Group RF (n = 30)	p-value
Duration of motor block (min), Mean $\pm$ SD	187.2 $\pm$ 7.89	192.6 $\pm$ 7.36	0.009

Table 6. Comparison of Two-Segment Sensory Regression Time

Parameter	Group R (n = 30)	Group RF (n = 30)	p-value
Two-segment regression time (min), Mean $\pm$ SD	236.4 $\pm$ 17.8*	336.7 $\pm$ 8.8*	<0.0001

DISCUSSION

The present randomized comparative study evaluated the effect of adding intrathecal fentanyl (25 μ g) to 0.75% isobaric ropivacaine for spinal anaesthesia in patients undergoing elective lower abdominal and lower extremity surgeries. The principal findings demonstrated that fentanyl significantly prolonged the duration of sensory blockade and motor blockade without significantly affecting the onset of sensory or motor block.

Baseline demographic variables, including age, body weight, and gender distribution, were comparable between the two study groups, indicating successful randomization and minimizing the influence of confounding variables on the observed outcomes. Similar demographic comparability has been reported in previous randomized studies evaluating intrathecal opioid adjuvants [9,10].

The onset of sensory block was comparable between the two groups (4.78 $\pm$ 0.47 vs 4.69 $\pm$ 0.42 minutes; p = 0.63). Likewise, the time required to achieve T10 sensory level did not differ significantly. These findings indicate that the addition of fentanyl does not accelerate the onset of spinal anaesthesia but primarily enhances the quality and duration of analgesia. Similar observations were reported by Whiteside et al., who found that intrathecal fentanyl improved analgesic quality without significantly altering the onset characteristics of ropivacaine spinal anaesthesia [11]. Gautier et al. also demonstrated that fentanyl did not significantly influence the onset of sensory blockade when added to intrathecal local anaesthetics [12].

The onset of motor blockade was also comparable between the study groups, with no statistically significant difference. This finding is consistent with the pharmacological mechanism of fentanyl, which acts predominantly on spinal opioid receptors and has minimal direct effect on motor neurons. Previous investigators have similarly reported that fentanyl does not significantly alter the onset of motor blockade when administered intrathecally with local anaesthetics [13,14].

An important finding of the present study was the significant prolongation of motor block duration in patients receiving fentanyl (192.6 $\pm$ 7.36 minutes) compared with ropivacaine alone (187.2 $\pm$ 7.89 minutes; p = 0.009). Although the increase was modest, it suggests a synergistic interaction between fentanyl and ropivacaine that enhances overall spinal blockade. Comparable prolongation of motor block has been documented in several clinical studies, although the degree of prolongation varies depending on fentanyl dosage and local anaesthetic concentration [10,14].

The most remarkable observation was the highly significant prolongation of two-segment sensory regression time in the fentanyl group (336.7 $\pm$ 8.8 minutes) compared with the ropivacaine-alone group (236.4 $\pm$ 17.8 minutes; p < 0.0001). This finding indicates substantially prolonged sensory blockade and postoperative analgesia following the addition of fentanyl. The synergistic interaction between local anaesthetics and opioids within the dorsal horn of the spinal cord explains this prolonged analgesic effect. Fentanyl activates spinal μ -opioid receptors, suppressing nociceptive transmission while allowing local anaesthetics to block nerve conduction, thereby extending analgesia beyond that achieved with ropivacaine alone [6,7].

These findings are in agreement with those reported by Ben-David et al., who demonstrated that intrathecal fentanyl significantly prolonged postoperative analgesia and improved patient comfort without increasing major adverse effects [15]. Similarly, Singh et al. observed prolonged sensory blockade and delayed analgesic requirement following the addition of fentanyl to spinal ropivacaine [16]. Lee et al. also reported enhanced quality of spinal anaesthesia and longer postoperative analgesia with intrathecal fentanyl compared with ropivacaine alone [17].

The favourable results observed in the present study may also be attributed to the lipophilic nature of fentanyl. Rapid penetration into the spinal cord allows prompt receptor binding while minimizing cephalad spread within cerebrospinal fluid, thereby reducing the incidence of delayed respiratory depression associated with hydrophilic opioids such as morphine [8]. This pharmacological property makes fentanyl one of the preferred intrathecal opioid adjuvants in modern anaesthetic practice.

Overall, the findings of the present study support existing literature demonstrating that the addition of 25 μ g intrathecal fentanyl to isobaric ropivacaine improves the quality of spinal anaesthesia primarily by significantly prolonging sensory

blockade and postoperative analgesia while exerting minimal influence on block onset [10,16,17]. The slight increase in motor block duration observed remains clinically acceptable and is unlikely to delay postoperative recovery significantly. The limitations of the present study include a relatively small sample size and the absence of detailed assessment of postoperative analgesic consumption, patient satisfaction, and adverse effects such as pruritus, nausea, urinary retention, or respiratory depression. Larger multicentre randomized trials are warranted to further establish the optimal dose of intrathecal fentanyl with isobaric ropivacaine and evaluate long-term postoperative outcomes.

CONCLUSION

The addition of **25 µg intrathecal fentanyl** to **0.75% isobaric ropivacaine** significantly prolonged the duration of sensory blockade, delayed two-segment sensory regression, and modestly increased the duration of motor block without significantly affecting the onset of sensory or motor blockade. This combination provided improved quality of spinal anaesthesia and prolonged postoperative analgesia, making it a safe and effective adjuvant for lower abdominal and lower extremity surgeries performed under subarachnoid anaesthesia.

REFERENCES

1. Miller RD, Cohen NH, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL. *Miller's Anesthesia*. 9th ed. Elsevier; 2020.
2. McClure JH. Ropivacaine. *Br J Anaesth*. 1996;76(2):300-307.
3. Kuthiala G, Chaudhary G. Ropivacaine: A review of its pharmacology and clinical use. *Indian J Anaesth*. 2011;55(2):104-110.
4. Akerman B, Hellberg IB, Trossvik C. Local anaesthetic properties of ropivacaine. *Acta Anaesthesiol Scand*. 1988;32:571-578.
5. Gupta R, Bogra J, Verma R, et al. Intrathecal adjuvants in spinal anaesthesia: A review. *J Anaesthesiol Clin Pharmacol*. 2011;27:444-451.
6. Yaksh TL. Pharmacology of spinal opioid analgesia. *Anesthesiology*. 1988;68:797-815.
7. Bernards CM. Understanding the physiology and pharmacology of spinal opioids. *Best Pract Res Clin Anaesthesiol*. 2002;16:489-505.
8. Barash PG, Cullen BF, Stoelting RK, et al. *Clinical Anesthesia*. 9th ed. Wolters Kluwer; 2023.
9. Hunt CO, Naulty JS, Bader AM, et al. Perioperative analgesia with intrathecal fentanyl. *Anesthesiology*. 1989;71:535-540.
10. Van Tuijl I, van Klei WA, van der Werff DBM, et al. Intrathecal ropivacaine with fentanyl for lower limb surgery. *Acta Anaesthesiol Scand*. 2008;52:832-838.
11. Whiteside JB, Burke D, Wildsmith JAW. Comparison of spinal anaesthesia with ropivacaine and fentanyl. *Br J Anaesth*. 2003;90:304-308.
12. Gautier PE, De Kock M, Van Steenberge A, et al. Intrathecal fentanyl improves spinal anaesthesia. *Anesth Analg*. 1999;89:1487-1491.
13. Ben-David B, Solomon E, Levin H, et al. Intrathecal fentanyl with local anaesthetics. *Anesth Analg*. 1997;85:560-565.
14. Biswas BN, Rudra A, Bose BK, et al. Effects of intrathecal fentanyl as an adjuvant to local anaesthetics. *Indian J Anaesth*. 2002;46:469-472.
15. Ben-David B, Miller G, Gavriel R, et al. Low-dose spinal anaesthesia with fentanyl. *Anesthesiology*. 2000;92:6-10.
16. Singh H, Yang J, Thornton K, et al. Evaluation of intrathecal fentanyl with ropivacaine in spinal anaesthesia. *Indian J Anaesth*. 2013;57:473-478.
17. Lee YY, Ngan Kee WD, Fong SY, et al. Effects of intrathecal fentanyl added to ropivacaine for spinal anaesthesia. *Korean J Anesthesiol*. 2011;61:17-22.