

Comparative Evaluation of Dexmedetomidine versus Fentanyl Added to Hyperbaric Levobupivacaine for Subarachnoid Block: Effects on Sensory-Motor Blockade and Analgesic Duration

Neethi T P¹, Prashanth Kumar C², Chaitra Uppangala^{3*}, Barbara Coelho², Nayanatara Arun Kumar³

Neethi T P¹, Prashanth Kumar C²,
Chaitra Uppangala^{3*}, Barbara
Coelho², Nayanatara Arun
Kumar³

¹Department of Anesthesiology, P K DAS Institute of Medical Sciences Palakkad, Kerala, INDIA.

²Department of Anesthesiology, Srinivas Institute of Medical Sciences and Research Centre, Mangalore, INDIA.

³Department of Physiology, Kasturba Medical College Mangalore, Manipal Academy of Higher Education, Manipal, India.

Correspondence

Dr. U. Chaitra

Department of Physiology, Kasturba Medical College Mangalore, Manipal Academy of Higher Education, Manipal, India.

E-mail: chaitra.uppangala@manipal.edu

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ABSTRACT

Introduction : Adjuvants to local anesthetics enhance the quality and duration of spinal anesthesia while reducing postoperative analgesic requirements. Opioids like fentanyl are effective but associated with significant side effects, whereas dexmedetomidine, an α 2-adrenergic agonist, has shown promise as a non-opioid alternative. **Objective :** To compare the effects of intrathecal dexmedetomidine and fentanyl, when added to levobupivacaine, on sensory and motor block characteristics, duration of analgesia, and complications in patients undergoing elective total abdominal hysterectomy. **Methods:** In this prospective, double-blind, randomized controlled trial, 60 ASA I-II female patients aged 18–65 years were allocated into two groups (n = 30 each). Group D received 15 mg 0.5% hyperbaric levobupivacaine with 5 μ g dexmedetomidine, and Group F received 15 mg 0.5% hyperbaric levobupivacaine with 25 μ g fentanyl intrathecally. Block onset, duration of sensory and motor blockade, time to first rescue analgesia, hemodynamic changes, and side effects were recorded. **Results:** Demographic variables were comparable between groups. The onset of sensory and motor block was significantly faster with fentanyl, while dexmedetomidine prolonged the duration of sensory block (458.83 vs 358.07 min, $p < 0.001$), motor block (287.33 vs 217.33 min, $p < 0.001$), and time to rescue analgesia (95.5 vs 55.5 min, $p < 0.001$). Hypotension was the most common complication in both groups, without significant difference between two groups. Pruritus was observed only in the fentanyl group, while bradycardia was rare and not significant in the dexmedetomidine group. **Conclusion:** Intrathecal dexmedetomidine, as an adjuvant to levobupivacaine, provides prolonged sensory and motor block and superior postoperative analgesia compared to fentanyl, with fewer side effects. It may be considered a preferable adjuvant for spinal anesthesia in total abdominal hysterectomy.

Keywords: Dexmedetomidine, fentanyl, levobupivacaine, subarachnoid block, spinal anesthesia, abdominal hysterectomy

INTRODUCTION

Spinal anesthesia is the preferred technique for most gynecological procedures as it offers several advantages over general anesthesia, including rapid onset, fewer systemic side effects, better postoperative recovery, and preservation of airway reflexes. Moreover, it is associated with minimal physiological disturbance, and hypotension following spinal anesthesia rarely leads to significant cardiac alterations¹. Local anesthetics form the cornerstone of subarachnoid block (SAB). However, their use is limited by a relatively short duration of action and potential systemic adverse effects when higher doses are required. To overcome these limitations, various adjuvants have been combined with local anesthetics to enhance block characteristics. Adjuvants not only prolong the duration of sensory and motor blockade but also allow for dose reduction of local anesthetics, thereby minimizing cardiovascular and central nervous system toxicity. They can be administered intrathecally or intravenously, and their use has become increasingly common in modern anesthetic practice.

Among intrathecal adjuvants, opioids such as fentanyl are widely used because of their

synergistic analgesic effects with local anesthetics, leading to improved block quality and extended postoperative analgesia². However, opioid-related adverse effects such as pruritus, nausea, vomiting, and respiratory depression remain a concern. This has encouraged exploration of non-opioid adjuvants. Dexmedetomidine, a highly selective α 2-adrenergic receptor agonist, has emerged as a promising non-opioid intrathecal adjuvant. It enhances the quality of spinal anesthesia, prolongs the duration of both sensory and motor block, and reduces postoperative analgesic requirements, without significant respiratory depression³. Its mechanism of action includes inhibition of nociceptive neurotransmission at the dorsal horn and augmentation of hyperpolarization of nerve tissues, thereby extending analgesia.

Despite these advantages, postoperative pain control remains a challenge in abdominal hysterectomy, where intraoperative and postoperative pain may limit the sole use of spinal anesthesia⁴. Therefore, identifying an adjuvant that provides effective intraoperative anesthesia, prolonged postoperative analgesia, and minimal side effects is clinically relevant. In this context, the present study was undertaken to comparatively evaluate the efficacy and safety of intrathecal dexmedetomidine (5 μ g)

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versus fentanyl (25 µg) as adjuvants to 0.5% hyperbaric levobupivacaine in patients undergoing elective total abdominal hysterectomy. The primary outcomes assessed were onset and duration of sensory and motor block, and time to first rescue analgesia. Secondary outcomes included intraoperative hemodynamic stability and incidence of complications.

MATERIALS AND METHODS

This prospective, double-blind, randomized controlled trial was conducted in the Department of Anesthesiology, Srinivas Institute of Medical Sciences and Research Center, Mukka, Karnataka, over a period of 18 months (August 2022–February 2024). After obtaining approval from the Institutional Ethics Committee and written informed consent, 60 female patients aged 18–65 years, belonging to ASA physical status I–II and scheduled for elective total abdominal hysterectomy, were enrolled. Patients with drug hypersensitivity, hepatic or renal dysfunction, bleeding disorders, uncontrolled systemic illness, spinal deformity, morbid obesity, or refusal to participate were excluded. Participants were randomized into two equal groups of 30 each using sealed opaque envelopes. Group D received 15 mg of 0.5% levobupivacaine (3 mL) with dexmedetomidine 5 µg (0.5 mL), while Group F received 15 mg of 0.5% levobupivacaine (3 mL) with fentanyl 25 µg (0.5 mL). The total intrathecal volume was 3.5 mL in both groups. A midline lumbar puncture was performed under aseptic precautions with a 26G Quincke needle, and the study drug was administered intrathecally by an anesthesiologist blinded to group allocation⁵.

Sensory block was assessed using loss of cold sensation to the T6 dermatome, while motor block was evaluated using the modified Bromage scale⁶. The duration of sensory block was defined as the time from intrathecal injection to regression to the S1 dermatome, and motor block duration as the time to return to Bromage score 0. Postoperative pain was assessed using the Visual Analogue Scale (VAS, 0–3), and rescue analgesia in the form of diclofenac 75 mg IV was given when VAS ≥2⁷. The time from subarachnoid block to first rescue analgesic requirement was considered the duration of effective analgesia. Sample size was calculated based on an expected mean difference of 0.7 with standard deviation of 0.5, a error of 0.05, and power of 80%, yielding a minimum of 28 patients per group. To account for possible dropouts, 30 patients were included in each group.

RESULTS

A total of 60 patients were analyzed, with 30 in each group. The two groups were comparable in demographic characteristics, including mean age (Figure 1), ASA physical status, and baseline diagnosis (Figure 2). The mean duration of surgery was also similar between the groups (Figure 3). The onset and regression of sensory and motor blockade are summarized in (Table 1). The mean onset time of sensory block at T10 was faster in the fentanyl group ($2.3 \pm \text{SD}$ minutes) compared to the dexmedetomidine group ($2.9 \pm \text{SD}$ minutes) (Figure 7). Similarly, the onset of sensory block to T6 and T12 levels was achieved earlier with fentanyl (Figure 4-6). The onset of motor block was also quicker in the fentanyl group (2.73 minutes) than in the dexmedetomidine group (3.57 minutes). These differences were statistically significant ($p < 0.001$). In contrast, the duration of blockade was significantly prolonged in the dexmedetomidine group

DISCUSSION

Subarachnoid block remains the anesthetic technique of choice for lower abdominal surgeries, including gynecological procedures, owing to its rapid onset, reliable efficacy, and favorable recovery profile. The addition of intrathecal adjuvants has been shown to enhance the quality and duration of spinal anesthesia while reducing postoperative analgesic requirements. In the present study, we

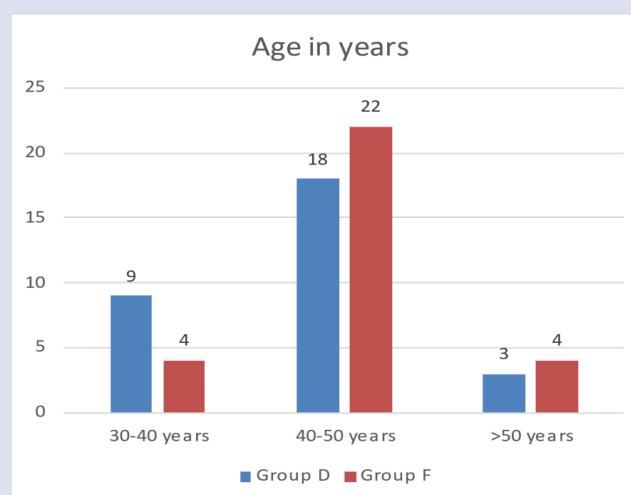


Figure 1. Comparison of age in years

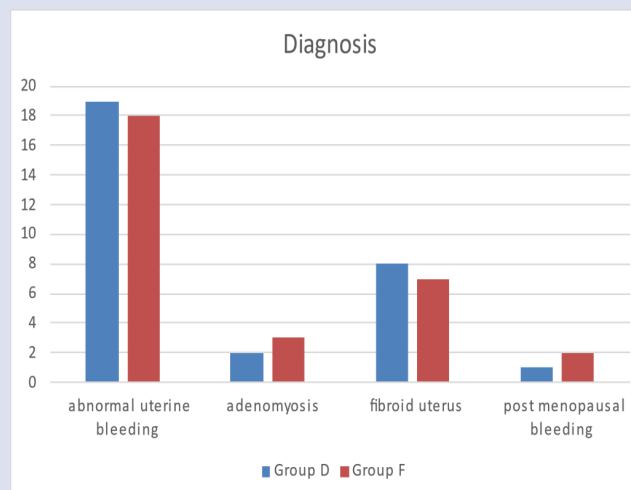


Figure 2. Comparison based on the diagnosis

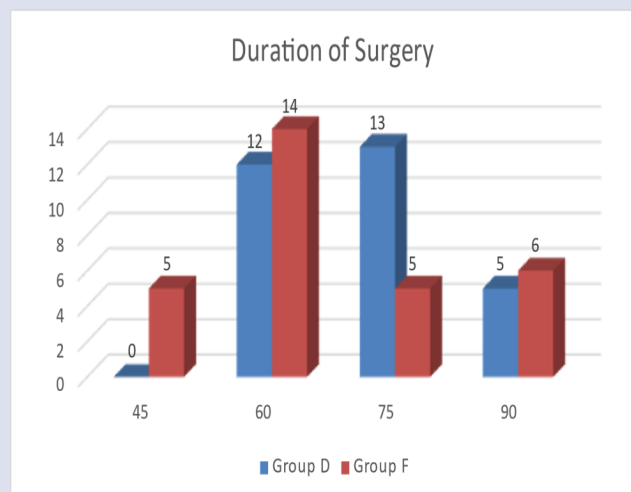


Figure 3. Comparison based on the duration of the surgery

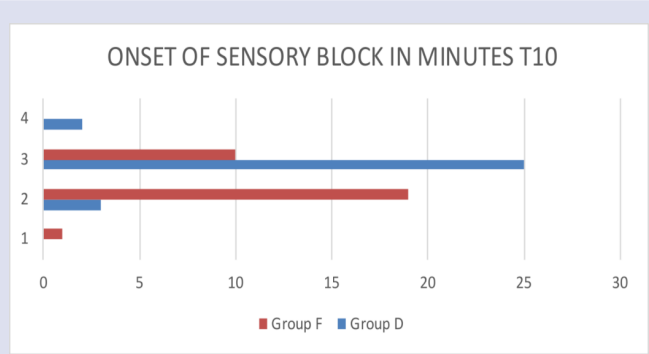


Figure 4. Comparison based on onset of sensory block in minutes T10

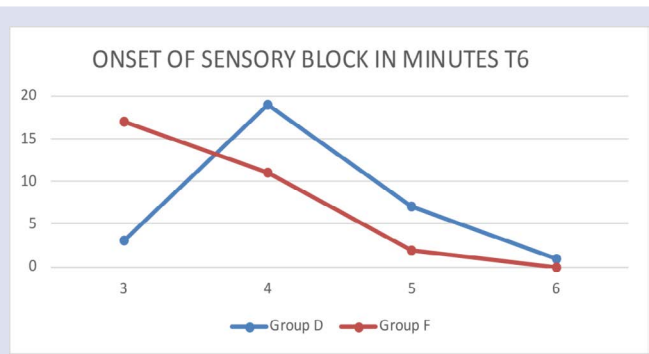


Figure 5. Comparison based on onset of sensory block in minutes T6

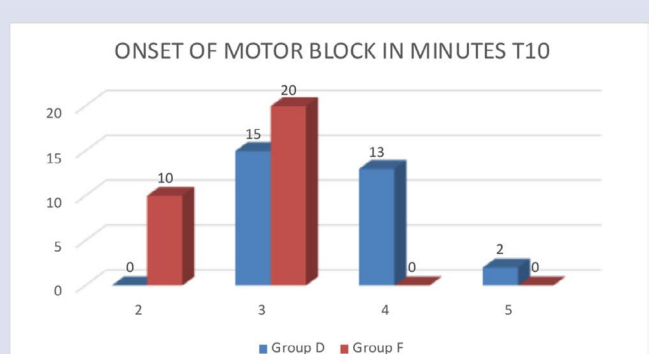


Figure 6. Comparison based on onset of sensory block to T12

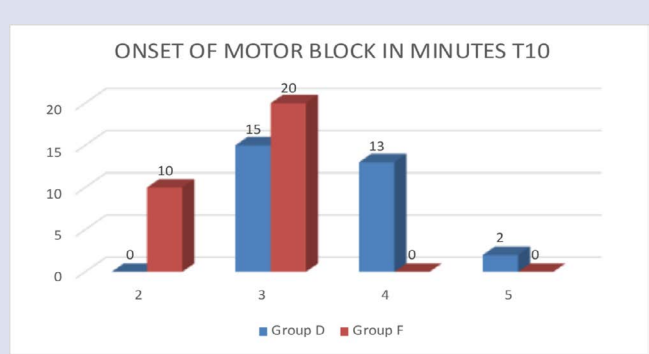


Figure 7. Comparison of onset of sensory and motor block to T10

Table 1. Comparison of onset and regression of sensory and motor blockade

Group		N	Mean	Std. Deviation	p-value
ONSET OF SENSORY BLOCK (IN MINUTES) TO T10	Group D	30	2.96	.414	0.001
	Group F	30	2.30	.535	
ONSET OF SENSORY BLOCK (IN MINUTES) TO T6	Group D	30	4.20	.664	0.001
	Group F	30	3.50	.630	
ONSET OF MOTOR BLOCK (IN MINUTES) TO T10	Group D	30	3.57	.626	0.001
	Group F	30	2.67	.479	
ONSET OF MOTOR BLOCK (IN MINUTES) TO T6	Group D	30	5.27	.691	0.001
	Group F	30	4.47	.571	
	Group F	30	66.00	15.052	
SENSORY BLOCK REGRESS TO S1 (IN MINUTES)	Group D	30	458.83	56.974	0.001
	Group F	30	358.07	46.022	
MOTOR BLOCK REGRESS TO S1 (IN MINUTES)	Group D	30	287.33	31.038	0.001
	Group F	30	212.33	39.034	

compared dexmedetomidine and fentanyl as intrathecal adjuvants to 0.5% hyperbaric levobupivacaine in patients undergoing elective total abdominal hysterectomy. We observed that fentanyl facilitated an earlier onset of both sensory and motor block compared to dexmedetomidine. Similar findings were reported by Rastogi et al⁸ and Belgrami et al⁹, who demonstrated a significantly faster block onset with intrathecal fentanyl. However, dexmedetomidine was superior in prolonging the duration of sensory and motor blockade, consistent with the findings of Gupta et al¹⁰ and Rastogi et al¹¹. This prolongation can be attributed to the α_2 -adrenergic receptor agonist action of dexmedetomidine, which enhances hyperpolarization of neurons at the dorsal horn, thereby inhibiting nociceptive transmission. The time to first rescue analgesia was also significantly longer in the dexmedetomidine group compared to fentanyl, suggesting improved postoperative analgesic efficacy. These results align with previous studies by Belgrami et al⁹ and Ibrahim et al¹², both of which confirmed the analgesia-prolonging effect of intrathecal dexmedetomidine. Thus, while fentanyl provides a quicker onset of block, dexmedetomidine ensures sustained perioperative analgesia, which may be advantageous in surgeries of longer duration such as hysterectomy. Regarding complications, hypotension was the most common adverse effect in both groups, though it was not statistically significant. Bradycardia, a known effect of α_2 agonists, was not clinically significant in our study, echoing the findings of Subi et al¹³. Importantly, pruritus was significantly higher in the fentanyl group, while absent in the dexmedetomidine group, confirming opioid-related pruritus as a common limitation of fentanyl¹⁴. Overall, our findings reinforce that dexmedetomidine, when used as an intrathecal adjuvant, provides a favorable balance between prolonged block characteristics and minimal side effects. However, the delayed onset of block with dexmedetomidine should be taken into consideration, especially in shorter procedures where rapid onset is desirable.

CONCLUSION

Intrathecal dexmedetomidine, when added to 0.5% hyperbaric levobupivacaine, significantly prolongs the duration of sensory and motor block and extends the time to first rescue analgesia compared to fentanyl, with fewer side effects such as pruritus. While fentanyl allows for a faster onset of blockade, dexmedetomidine provides superior postoperative analgesia and block quality, making it a suitable adjuvant for spinal anesthesia in total abdominal hysterectomy.

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