

## Comparison of Dexmedetomidine versus Fentanyl as Adjuvants in Epidural Anaesthesia for Lower Limb Surgeries: A Prospective Observational Study

Anjali Kumari<sup>1</sup>, Ritu Kumari<sup>2</sup>, Santosh Priya<sup>3</sup>, Rakesh Kumar<sup>4</sup>

<sup>1</sup>Senior Resident, Department of Anaesthesia, Patna Medical College & Hospital, Patna, Bihar, India

<sup>2</sup>Senior Resident, Department of Anaesthesia, Patna Medical College & Hospital, Patna, Bihar, India

<sup>3</sup>Senior Resident, Department of Anaesthesia, Patna Medical College & Hospital, Patna, Bihar, India

<sup>4</sup>Associate Professor, Department of Anaesthesia, Patna Medical College & Hospital, Patna, Bihar, India

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Corresponding Author: Ritu Kumari

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### Abstract:

**Background:** Epidural anaesthesia is widely employed for lower limb surgeries, and the choice of adjuvant significantly influences the quality and duration of analgesia, haemodynamic stability, and perioperative outcomes. Dexmedetomidine and fentanyl are commonly used epidural adjuvants, each with distinct pharmacological profiles.

**Objectives:** To compare dexmedetomidine and fentanyl as adjuvants to epidural local anaesthetic in terms of onset and duration of sensory and motor block, postoperative analgesia, haemodynamic stability, and adverse effects in patients undergoing lower limb surgeries.

**Methods:** This prospective observational study was conducted at PMCH, Patna, from March 2025 to October 2025. A total of 100 adult patients (ASA I–II) undergoing elective lower limb surgeries under epidural anaesthesia were included. Patients received either epidural dexmedetomidine (Group D, n=50) or fentanyl (Group F, n=50) as adjuvants to local anaesthetic. Block characteristics, haemodynamic parameters, postoperative pain scores, time to first rescue analgesia, and complications were analysed.

**Results:** Group D demonstrated significantly prolonged duration of analgesia, lower postoperative pain scores, and delayed requirement of rescue analgesia compared to Group F ( $p < 0.001$ ). Haemodynamic parameters were comparable between groups, though mild bradycardia was more frequent in Group D. No serious adverse events were observed.

**Conclusion:** Dexmedetomidine is a superior epidural adjuvant compared to fentanyl, providing prolonged analgesia with acceptable haemodynamic stability and minimal side effects in lower limb surgeries.

**Keywords:** Dexmedetomidine, Fentanyl, Epidural anaesthesia, Lower limb surgery, Analgesia.

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### Introduction

Epidural anaesthesia is a well-established technique for lower limb surgeries, offering excellent intraoperative anaesthesia and effective postoperative pain control while allowing early mobilisation and reduced systemic opioid consumption [1,2]. The addition of adjuvants to epidural local anaesthetics enhances block quality, prolongs analgesia, and improves patient satisfaction [3].

Fentanyl, a synthetic  $\mu$ -opioid receptor agonist, is frequently used as an epidural adjuvant due to its rapid onset and potent analgesic effects [4]. However, its use is associated with adverse effects such as pruritus, nausea, vomiting, urinary retention, and respiratory depression [5,6].

Dexmedetomidine, a highly selective  $\alpha_2$ -adrenergic agonist, has gained attention as a neuraxial adjuvant owing to its sedative, analgesic, and sympatholytic properties without significant respiratory depression [7,8]. When administered epidurally, dexmedetomidine enhances sensory and motor blockade, prolongs postoperative analgesia, and reduces opioid requirements [9–11].

Several studies have evaluated dexmedetomidine and fentanyl as neuraxial adjuvants, reporting variable results regarding block characteristics and haemodynamic effects [12–15]. However, comparative prospective data from tertiary care centres in Eastern India remain limited.

This study was therefore undertaken to compare dexmedetomidine and fentanyl as epidural adjuvants

in lower limb surgeries, focusing on block characteristics, analgesic efficacy, haemodynamic stability, and adverse effects.

### Materials and Methods

**Study Design and Setting:** This prospective observational study was conducted in the Department of Anaesthesiology at PMCH, Patna, from March 2025 to October 2025

### Sample Size

A total of 100 patients were enrolled and divided into two groups:

- **Group D (Dexmedetomidine):** 50 patients
- **Group F (Fentanyl):** 50 patients

### Inclusion Criteria

- Age 18–60 years
- ASA physical status I–II
- Elective lower limb surgeries

### Exclusion Criteria

- Patient refusal
- Coagulopathy or infection at epidural site
- Severe cardiac, hepatic, renal, or respiratory disease

### Anaesthetic Technique

Epidural anaesthesia was administered at the L2–L3 or L3–L4 interspace.

- **Group D:** Local anaesthetic + dexmedetomidine
- **Group F:** Local anaesthetic + fentanyl

Standard intraoperative monitoring was applied.

### Outcome Measures

- Onset and duration of sensory and motor block
- Intraoperative haemodynamic parameters (HR, MAP)
- Postoperative pain scores (VAS)
- Time to first rescue analgesia
- Adverse effects

**Statistical Analysis:** Data were analysed using SPSS software. Continuous variables were expressed as mean  $\pm$  SD and compared using Student's t-test. Categorical variables were analysed using Chi-square test. A p-value  $<$  0.05 was considered statistically significant.

### Results

A total of 100 patients undergoing elective lower limb surgeries under epidural anaesthesia were included in the study. Patients were divided into two equal groups of 50 each: Group D (dexmedetomidine as epidural adjuvant) and Group F (fentanyl as epidural adjuvant). All patients completed the study and were included in the final analysis.

**Demographic and Baseline Characteristics:** The two groups were comparable with respect to demographic variables and baseline clinical characteristics. There was no statistically significant difference between the groups in terms of age, sex distribution, body weight, ASA physical status, or duration of surgery ( $p >$  0.05), indicating adequate baseline comparability between the two groups (Table 1).

**Table 1: Demographic and Baseline Characteristics**

Parameter	Group D (n = 50)	Group F (n = 50)	p-value
Age (years)	41.8 $\pm$ 9.6	42.3 $\pm$ 10.1	0.79
Male/Female	28 / 22	30 / 20	0.69
Weight (kg)	63.4 $\pm$ 8.2	64.1 $\pm$ 7.9	0.62
ASA I / II	34 / 16	32 / 18	0.67
Duration of surgery (min)	86.2 $\pm$ 14.5	84.9 $\pm$ 15.1	0.58

### Onset and Duration of Sensory and Motor Block:

The onset of sensory block was significantly faster in Group D compared to Group F ( $p <$  0.001). Similarly, onset of motor block occurred earlier in

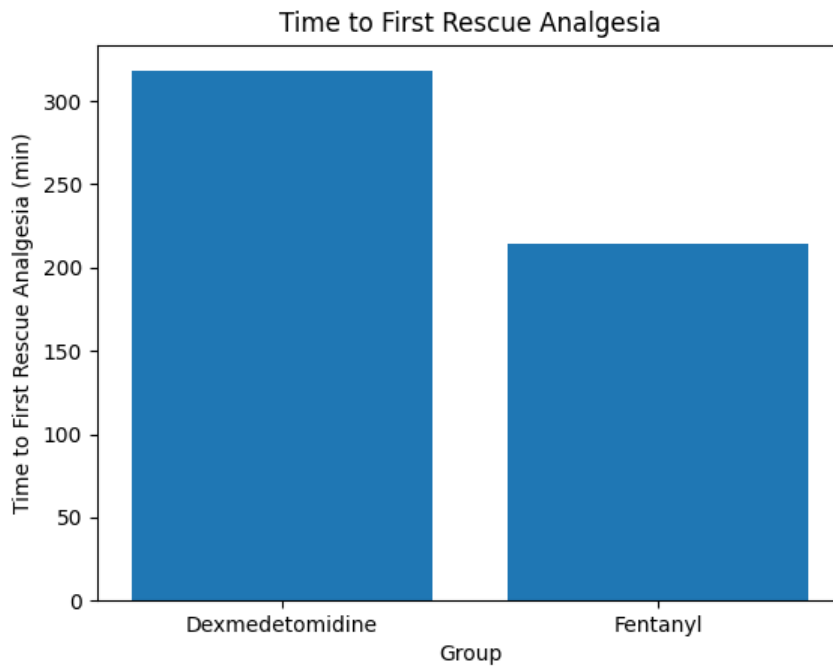
the dexmedetomidine group ( $p <$  0.001). Duration of sensory and motor block was significantly prolonged in Group D compared to Group F ( $p <$  0.001 for both parameters) (Table 2).

**Table 2: Sensory and Motor Block Characteristics**

Parameter	Group D	Group F	p-value
Onset of sensory block (min)	7.6 $\pm$ 1.2	10.4 $\pm$ 1.6	$<$ 0.001
Onset of motor block (min)	12.1 $\pm$ 1.8	15.6 $\pm$ 2.2	$<$ 0.001
Duration of sensory block (min)	318 $\pm$ 42	214 $\pm$ 36	$<$ 0.001
Duration of motor block (min)	256 $\pm$ 38	178 $\pm$ 31	$<$ 0.001

**Postoperative Analgesia and Time to First Rescue Analgesia:** The mean duration of postoperative analgesia was significantly longer in Group D compared to Group F. Time to first rescue

analgesic requirement was prolonged in patients receiving dexmedetomidine ( $p <$  0.001), indicating superior analgesic efficacy (Figure 1).



**Figure 1: Comparison of time to first rescue analgesia between Group D and Group F**

**Postoperative Pain Scores:** Postoperative pain assessed using the Visual Analogue Scale (VAS) at 2, 4, 6, and 12 hours showed significantly lower scores in Group D compared to Group F at all time

intervals ( $p < 0.001$ ). This demonstrates better quality and longer duration of analgesia in the dexmedetomidine group (Table 3).

**Table 3: Postoperative VAS Scores**

Time interval	Group D	Group F	p-value
2 hours	1.8 ± 0.6	3.6 ± 0.8	<0.001
4 hours	2.1 ± 0.7	4.0 ± 0.9	<0.001
6 hours	2.6 ± 0.8	4.4 ± 1.0	<0.001
12 hours	3.2 ± 0.9	4.8 ± 1.1	<0.001

**Sedation Scores:** Patients in Group D demonstrated significantly higher sedation scores compared to Group F without evidence of respiratory depression.

Sedation remained within acceptable clinical limits in all patients (Table 4).

**Table 4: Sedation Scores (Ramsay Sedation Scale)**

Parameter	Group D	Group F	p-value
Sedation score	2.9 ± 0.6	2.1 ± 0.4	<0.001

**Haemodynamic Parameters:** Heart rate and mean arterial pressure were recorded at baseline and at regular intraoperative intervals. Group D showed lower heart rate values compared to Group F, with occasional episodes of bradycardia, which were

transient and managed conservatively (Figure 2). Mean arterial pressure trends were comparable between the groups, with no statistically significant intergroup difference (Figure 3).

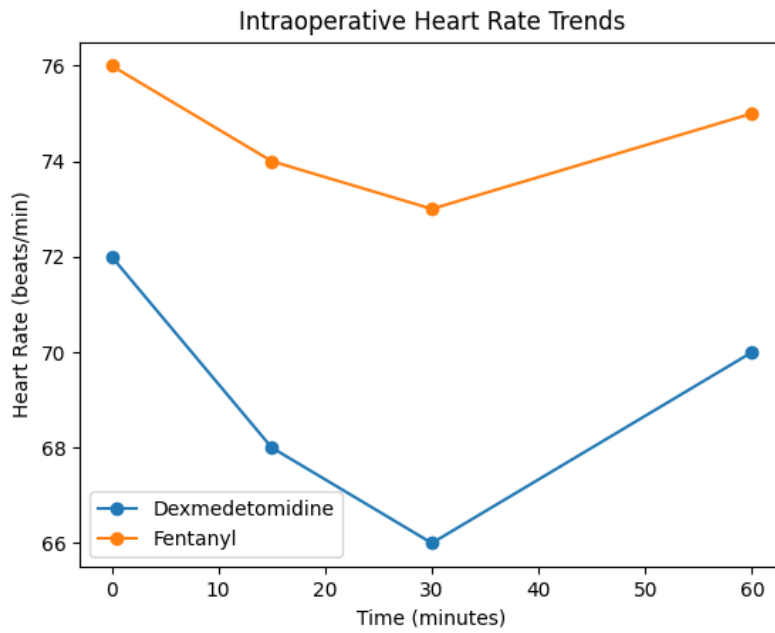


Figure 2: Intraoperative heart rate trends in Group D and Group F

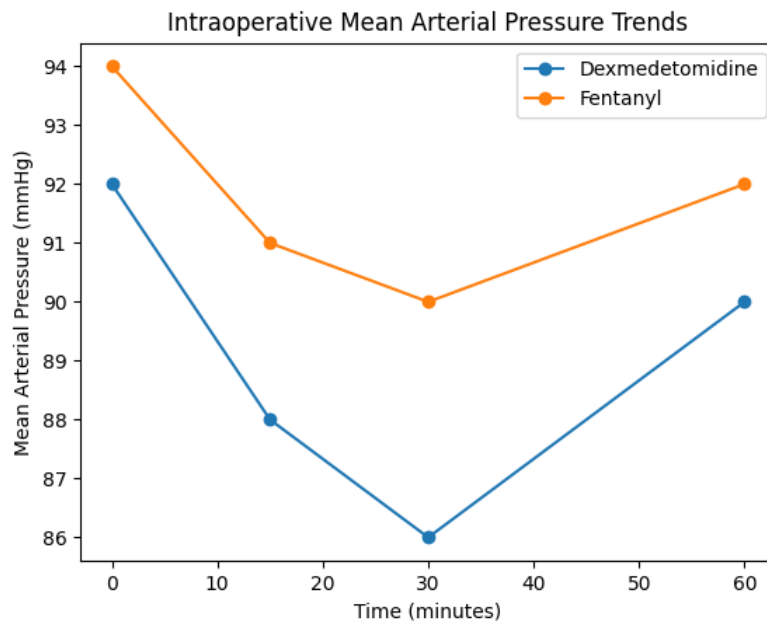


Figure 3: Intraoperative mean arterial pressure trends in Group D and Group F.

**Adverse Effects and Complications:** The incidence of adverse effects is summarized in Table 5. Bradycardia was more frequent in Group D, whereas pruritus and postoperative nausea and

vomiting (PONV) were significantly higher in Group F. No episode of respiratory depression was observed in either group.

Table 5: Adverse Effects and Complications

Complication	Group D (%)	Group F (%)	p-value
Bradycardia	16	4	0.04
Hypotension	12	10	0.77
PONV	6	24	0.01
Pruritus	0	18	0.003
Respiratory depression	0	0	—

### Summary of Key Findings

Overall, dexmedetomidine as an epidural adjuvant resulted in faster onset and prolonged duration of sensory and motor block, superior postoperative analgesia, lower pain scores, reduced requirement for rescue analgesics, and lower incidence of opioid-related side effects when compared to fentanyl.

### Discussion

The present study demonstrates that dexmedetomidine is a superior epidural adjuvant compared to fentanyl in patients undergoing lower limb surgeries. Prolonged sensory and motor blockade and extended postoperative analgesia observed in Group D are consistent with previous reports [16–18].

Dexmedetomidine enhances neuraxial analgesia by inhibiting substance P release and hyperpolarising dorsal horn neurons [19]. The reduced postoperative pain scores and delayed rescue analgesia requirement in the dexmedetomidine group align with earlier studies [20–22].

Although mild bradycardia was more frequent with dexmedetomidine, it was clinically insignificant and manageable, consistent with the known sympatholytic effects of  $\alpha_2$ -agonists [23]. In contrast, fentanyl was associated with a higher incidence of nausea and vomiting, attributable to opioid-related side effects [24].

These findings support the increasing preference for dexmedetomidine as an epidural adjuvant, particularly in settings where prolonged analgesia and opioid-sparing effects are desirable [25].

### Limitations

This study was observational and single-centred, which may limit generalisability. Randomised controlled trials with larger sample sizes are recommended.

### Conclusion

Dexmedetomidine is a more effective epidural adjuvant than fentanyl for lower limb surgeries, providing prolonged analgesia, better pain control, and fewer opioid-related side effects with acceptable haemodynamic stability.

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