



RESEARCH ARTICLE

Comparative Evaluation of Intrathecal Clonidine and Fentanyl as Adjuvants to Hyperbaric Bupivacaine for Spinal Anaesthesia in Lower Limb Orthopaedic Surgery

Praveen Mulchand Johare* 

¹Associate Professor , Department of Anaesthesiology, Mamta Medical College ,Khammam

Abstract

Background: Spinal anaesthesia with bupivacaine alone provides reliable intraoperative anaesthesia but limited postoperative analgesia. Intrathecal adjuvants such as clonidine and fentanyl have been used to prolong analgesia, each acting through distinct receptor mechanisms.

Objectives: To compare block characteristics, sedation, duration of postoperative analgesia, and side effects between intrathecal clonidine and fentanyl as adjuvants to hyperbaric bupivacaine in lower limb orthopaedic surgery.

Results: Duration of sensory block (268.4 ± 32.7 min vs 198.3 ± 26.4 min), motor block (224.7 ± 28.3 min vs 182.5 ± 24.1 min), and effective analgesia (342.6 ± 38.9 min vs 246.8 ± 31.5 min) were all significantly longer in the clonidine group than the fentanyl group (all $p < 0.001$). Rescue analgesia was required in 18.0% of the clonidine group compared with 42.0% of the fentanyl group. Sedation scores were higher with clonidine, while pruritus was more common with fentanyl.

Methods: This was a prospective, randomised, double-blind study of 100 patients undergoing lower limb orthopaedic surgery under spinal anaesthesia, allocated to receive intrathecal bupivacaine 15 mg with either clonidine 50 mcg (Group C, $n=50$) or fentanyl 25 mcg (Group F, $n=50$). Onset and duration of sensory and motor block, sedation score, duration of effective analgesia, requirement for rescue analgesia, and side effects were recorded and compared.

Conclusion: Intrathecal clonidine provides significantly longer postoperative analgesia than fentanyl when used as an adjuvant to hyperbaric bupivacaine for spinal anaesthesia in lower limb orthopaedic surgery, at the cost of greater sedation, while fentanyl is associated with a higher incidence of pruritus.

Keywords: : Spinal anaesthesia, intrathecal clonidine, intrathecal fentanyl, adjuvant, postoperative analgesia.

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1 | INTRODUCTION

Spinal anaesthesia with local anaesthetic alone provides reliable intraoperative surgical anaesthesia but is limited by a relatively short duration of postoperative analgesia, necessitating early administration of systemic analgesics in the postoperative period. Intrathecal adjuvants have therefore been extensively studied as a means of prolonging block duration and postoperative analgesia without a corresponding increase in local anaesthetic dose and its associated risks. (1)

Clonidine, an alpha-2 adrenergic agonist, produces analgesia through activation of alpha-2 receptors in the spinal dorsal horn, inhibiting nociceptive transmission, and has been shown in multiple dose-response studies to prolong both sensory and motor block duration when added to intrathecal local anaesthetics. (2, 3) Fentanyl, a lipophilic mu-opioid receptor agonist, acts predominantly at spinal opioid receptors to enhance analgesic quality and prolong block duration, though generally to a lesser extent than clonidine, and carries a distinct side effect profile, most notably pruritus. (4, 5)

Comparative studies of these two adjuvants have generally found clonidine to provide longer duration of analgesia than fentanyl, albeit with greater sedation, while fentanyl offers a more favourable haemodynamic profile with a lower incidence of bradycardia and hypotension.³ Given the ongoing clinical use of both adjuvants and the practical importance of selecting the most appropriate agent for a given surgical and patient context, further comparative evaluation remains valuable.

This study was undertaken to compare block characteristics, sedation, duration of postoperative analgesia, and side effects between intrathecal clonidine and fentanyl as adjuvants to hyperbaric bupivacaine in patients undergoing lower limb orthopaedic surgery under spinal anaesthesia.

2 | MATERIALS AND METHODS

2.1 | Study Design and Setting

This was a hospital-based, prospective, randomised, double-blind, comparative clinical study conducted in the Department of Anaesthesiology of a tertiary care teaching hospital over a defined study period.

2.2 | Study Population

One hundred ASA physical status I or II patients aged 18-65 years undergoing elective lower limb orthopaedic surgery under spinal anaesthesia were enrolled after obtaining informed consent.

2.3 | Inclusion and Exclusion Criteria

Patients aged 18-65 years, ASA physical status I or II, undergoing elective lower limb orthopaedic surgery expected to last 60-150 minutes, were included. Patients with contraindication to spinal anaesthesia, known allergy to study drugs, cardiac conduction abnormalities, or chronic opioid use were excluded.

2.4 | Anaesthetic Technique

Patients were randomly allocated to Group C (bupivacaine 15 mg with clonidine 50 mcg) or Group F (bupivacaine 15 mg with fentanyl 25 mcg), prepared by an anaesthesiologist not involved in patient assessment to maintain blinding. Spinal anaesthesia was performed at the L3-L4 interspace with a 25G Quincke spinal needle. Sensory block was assessed by loss of pinprick sensation and motor block by the modified Bromage scale.

Supplementary information The online version of this article ([10.15520/ijmhs/1-june-2010](https://doi.org/10.15520/ijmhs/1-june-2010)) contains supplementary material, which is available to authorized users.

Corresponding Author: *Praveen Mulchand Johare Associate Professor , Department of Anaesthesiology, Mamta Medical College ,Khammam*

2.5 | Monitoring and Outcome Assessment

Heart rate, blood pressure, and oxygen saturation were monitored throughout surgery and postoperatively. Sedation was assessed using the Ramsay Sedation Scale at 30 minutes and 1, 2, 4, and 6 hours postoperatively. Duration of effective analgesia was defined as the time from intrathecal injection to first request for rescue analgesia, assessed using a visual analogue scale, with rescue analgesia administered when the score exceeded 4/10.

2.6 | Statistical Analysis

Data were analysed using descriptive statistics; continuous variables were expressed as mean $\pm$ SD and compared using the independent samples t-test, and categorical variables were expressed as frequencies and percentages and compared using the chi-square test. A p-value <0.05 was considered statistically significant.

3 | RESULTS

The two groups were comparable at baseline for age, weight, and ASA physical status (Table 1).

Duration of sensory block, motor block, and effective analgesia were all significantly longer in the clonidine group than the fentanyl group (Table 2, Figure 1).

Sedation scores were consistently higher in the clonidine group compared with the fentanyl group at all assessed time points (Table 3, Figure 2).

Rescue analgesia was required in 9 (18.0%) patients in the clonidine group compared with 21 (42.0%) patients in the fentanyl group within 6 hours postoperatively (Table 4, Figure 3).

Hypotension and bradycardia were more frequent in the clonidine group, while pruritus occurred exclusively in the fentanyl group (Table 5, Figure 4).

4 | DISCUSSION

The significantly longer duration of sensory and motor block and postoperative analgesia observed with clonidine compared with fentanyl in this study is consistent with the pharmacological review by Eisenach and colleagues describing the analgesic mechanism of intrathecal alpha-2 agonists, and with the dose-response data of Strebel and colleagues, who similarly demonstrated dose-dependent prolongation of block duration with small-dose intrathecal clonidine. (6, 7) The magnitude of prolongation observed in this study is broadly consistent with that reported by Sethi and colleagues in their evaluation of low-dose intrathecal clonidine as an adjuvant to bupivacaine. (8)

The greater sedation observed with clonidine in this study reflects its central alpha-2 agonist activity, which produces dose-dependent sedation in addition to its spinal analgesic effect, a phenomenon well documented in the dose-response study of Filos and colleagues.⁶ While this sedative effect may be undesirable in some clinical contexts, it may also confer anxiolytic benefit in others, and should be weighed against the substantially reduced requirement for rescue analgesia observed with clonidine in this study.

The higher incidence of pruritus observed with fentanyl in this study is a well-recognised class effect of intrathecal opioids, consistent with earlier descriptions by Hunt and colleagues and Belzarena in their studies of intrathecal fentanyl for obstetric and general surgical analgesia. (4, 5) Conversely, the comparatively favourable haemodynamic profile of fentanyl relative to clonidine observed in this study, with lower rates of hypotension and bradycardia, is consistent with the reduced sympatholytic activity of opioid compared with alpha-2 agonist adjuvants. (8, 9)

Taken together, these findings suggest that the choice between clonidine and fentanyl as an intrathecal adjuvant should be individualised based on the clinical priority in a given patient: clonidine may be preferred where prolonged postoperative analgesia is the primary goal, particularly in settings with limited access to regular postoperative analgesic administration, while fentanyl may be preferred where

TABLE 1: Demographic and Baseline Characteristics

Parameter	Group C: Clonidine (n=50)	Group F: Fentanyl (n=50)
Age (years), mean $\pm$ SD	42.6 $\pm$ 11.4	41.8 $\pm$ 10.9
Weight (kg), mean $\pm$ SD	64.3 $\pm$ 8.6	65.1 $\pm$ 8.2
ASA physical status I, n (%)	38 (76.0%)	40 (80.0%)
ASA physical status II, n (%)	12 (24.0%)	10 (20.0%)

TABLE 2: Block Characteristics

Block Characteristic	Group C: Clonidine	Group F: Fentanyl	P-value
Onset of sensory block (min)	4.6 $\pm$ 1.1	4.2 $\pm$ 1.0	0.058
Duration of sensory block (min)	268.4 $\pm$ 32.7	198.3 $\pm$ 26.4	<0.001
Duration of motor block (min)	224.7 $\pm$ 28.3	182.5 $\pm$ 24.1	<0.001
Duration of effective analgesia (min)	342.6 $\pm$ 38.9	246.8 $\pm$ 31.5	<0.001

Figure 1: Block Characteristics: Clonidine versus Fentanyl as Adjuvant

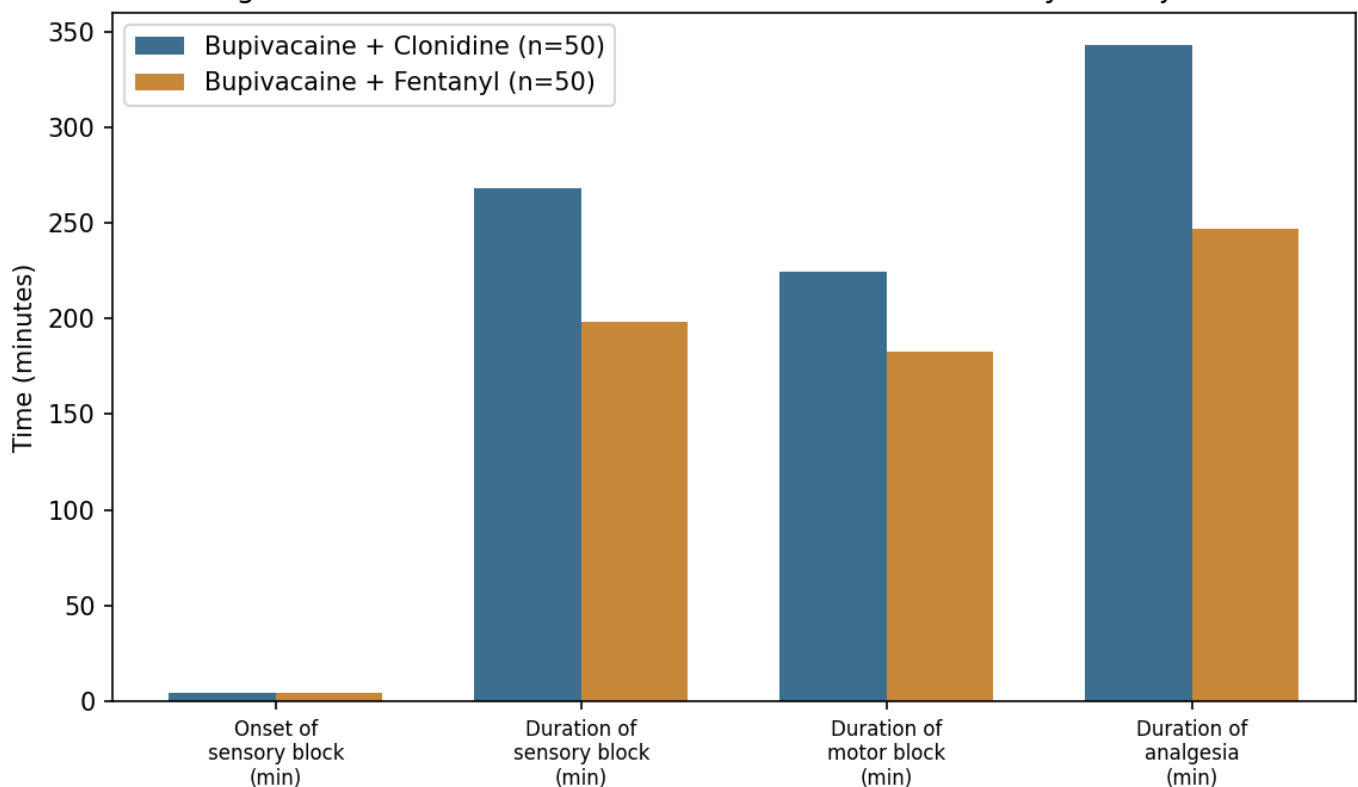


FIGURE 1:

TABLE 3: Sedation Score Trend Postoperatively

Time	Sedation Score: Clonidine (Ramsay)	Sedation Score: Fentanyl (Ramsay)
30 minutes	2.1 $\pm$ 0.5	1.2 $\pm$ 0.4
1 hour	1.8 $\pm$ 0.4	0.9 $\pm$ 0.3
2 hours	1.4 $\pm$ 0.4	0.6 $\pm$ 0.3
4 hours	1.0 $\pm$ 0.3	0.3 $\pm$ 0.2
6 hours	0.4 $\pm$ 0.2	0.1 $\pm$ 0.1

Figure 2: Sedation Score Trend Postoperatively

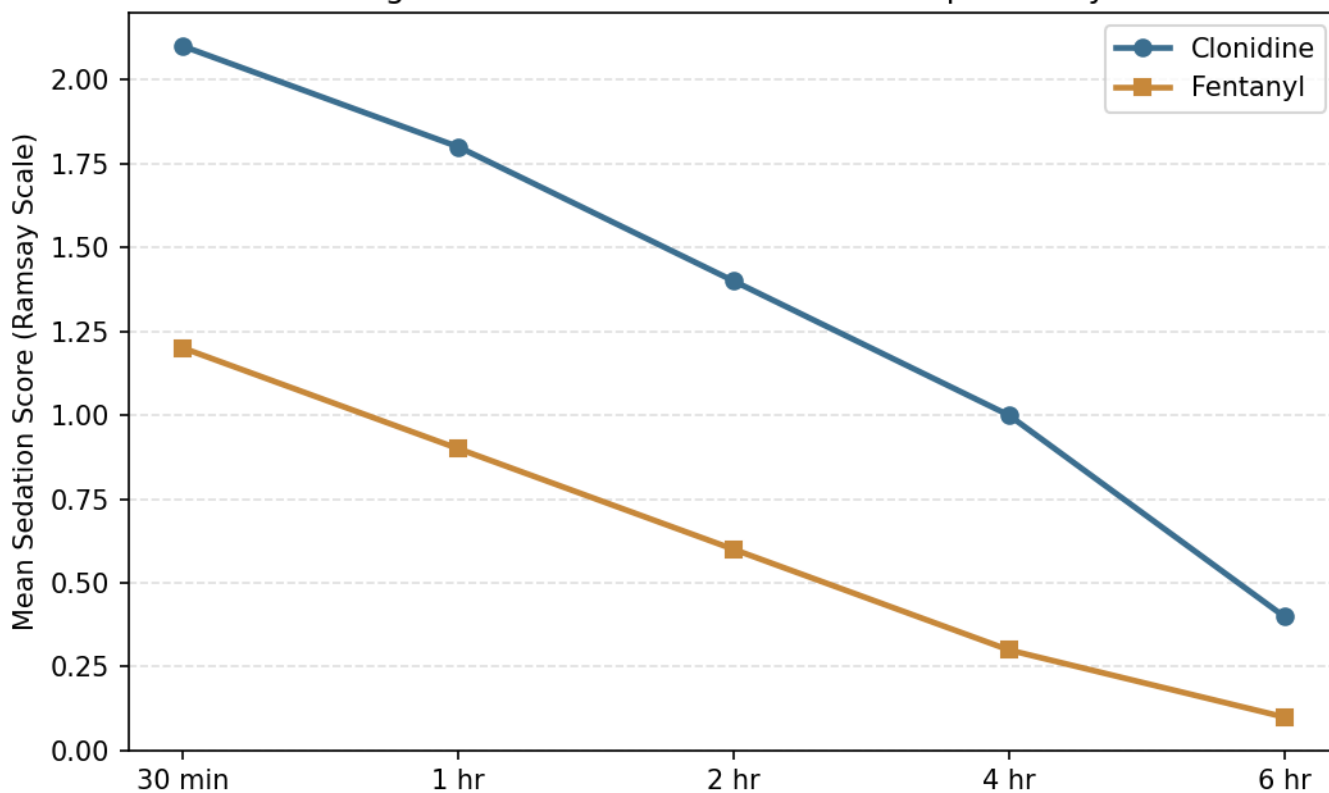


FIGURE 2:

TABLE 4: Requirement for Rescue Analgesia Within 6 Hours

Group	Required Rescue Analgesia, n (%)	No Rescue Required, n (%)
Group C: Clonidine (n=50)	9 (18.0%)	41 (82.0%)
Group F: Fentanyl (n=50)	21 (42.0%)	29 (58.0%)

Figure 3: Requirement for Rescue Analgesia Within 6 Hours

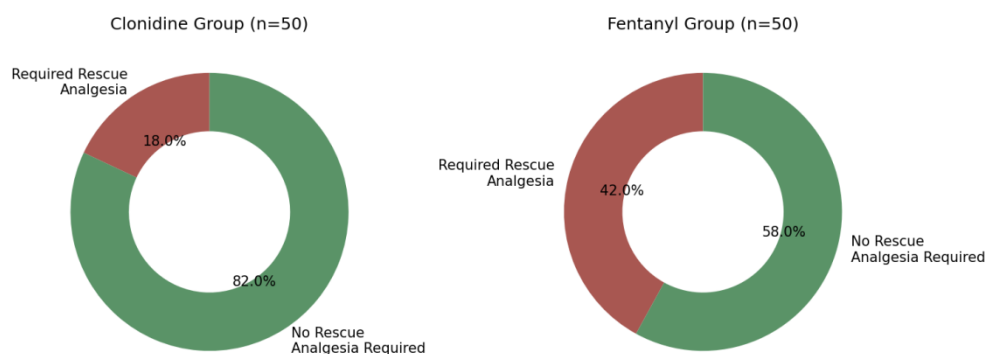


FIGURE 3:

TABLE 5: Side Effects by Study Group

Side Effect	Group C: Clonidine, n (%)	Group F: Fentanyl, n (%)
Hypotension	6 (12.0%)	3 (6.0%)
Bradycardia	5 (10.0%)	2 (4.0%)
Nausea/vomiting	3 (6.0%)	5 (10.0%)
Pruritus	0 (0.0%)	7 (14.0%)

Figure 4: Side Effects by Study Group

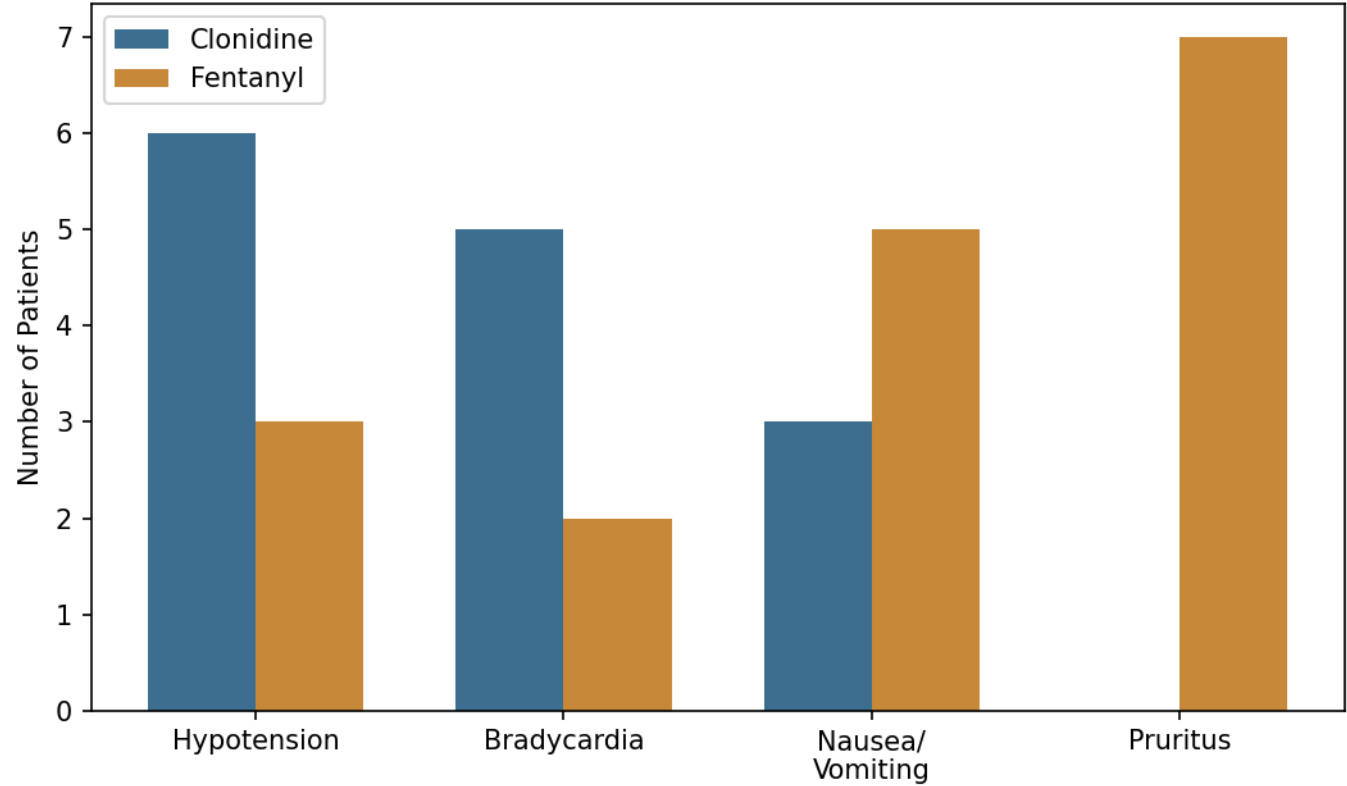


FIGURE 4:

haemodynamic stability and minimal sedation are prioritised, consistent with the balanced perspective offered in the review by Racle and colleagues on adjuvant use in spinal anaesthesia for elderly and higher-risk patients. (9)

5 | STRENGTHS AND LIMITATIONS

This study’s strengths include its randomised, double-blind design and standardised assessment protocol for block characteristics, sedation, and analgesia. Limitations include the absence of a formal a priori sample size calculation in this

template, which should be included in any real study; the use of a single fixed dose of each adjuvant rather than a dose-response design; and the relatively short follow-up period, which did not extend beyond 6 hours postoperatively and therefore does not capture very late analgesic requirements or complications.

6 | CONCLUSION

Intrathecal clonidine provides significantly longer postoperative analgesia than fentanyl when used as an adjuvant to hyperbaric bupivacaine for spinal anaesthesia in lower limb orthopaedic surgery, at

Figure 5: Study Design Comparing Intrathecal Clonidine and Fentanyl as Adjuncts to Bupivacaine

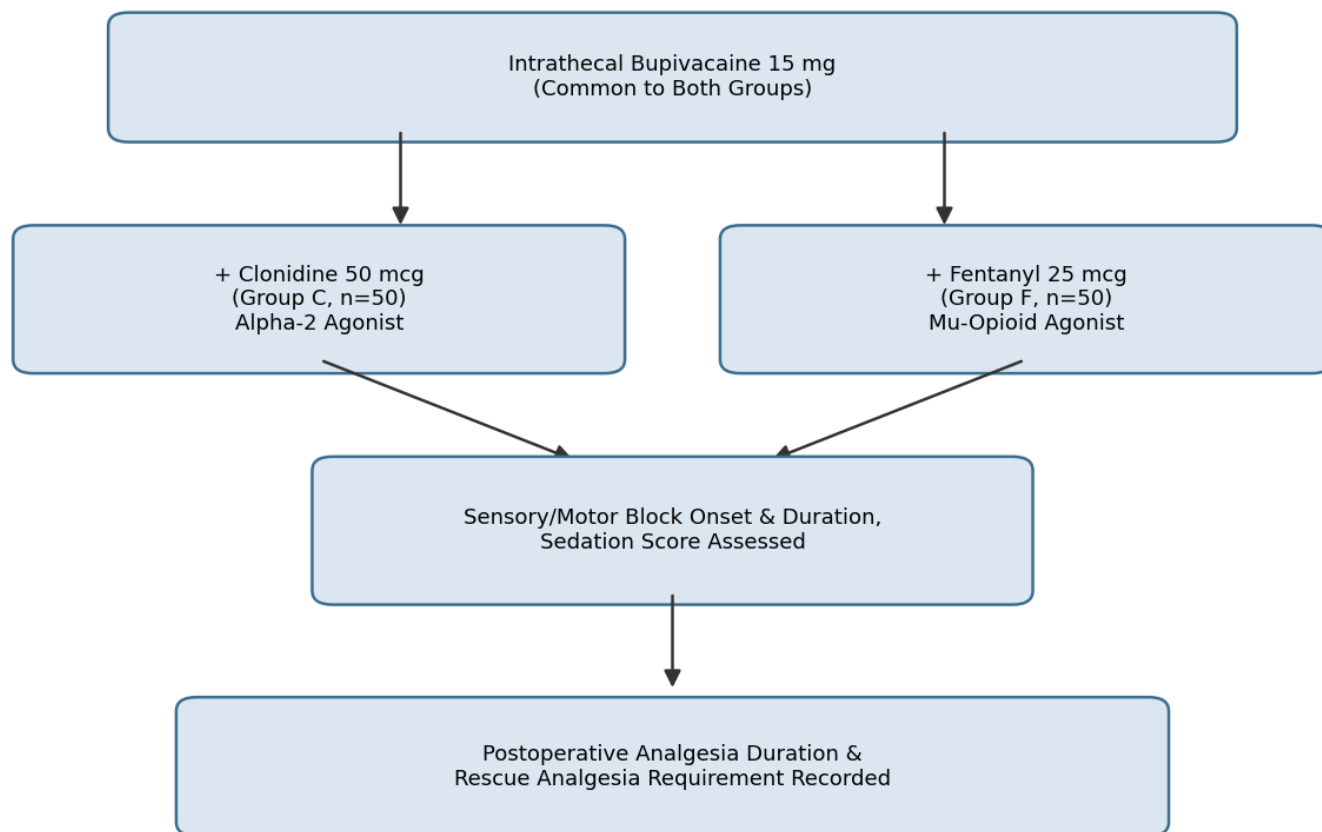


FIGURE 5: Study design comparing intrathecal clonidine and fentanyl as adjuncts to bupivacaine.

the cost of greater sedation and a modestly higher incidence of hypotension and bradycardia, while fentanyl offers a more favourable haemodynamic profile but a higher incidence of pruritus and greater requirement for rescue analgesia. Adjuvant selection should be individualised based on clinical priorities in each patient.

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