International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 4,2025
https://theaspd.com/index.php

A Comparative Study Of Intrathecal Hyperbaric Bupivacaine 0.5% With Clonidine Versus Plain Hyperbaric Bupivacaine 0.5% In Adults Undergoing Lower Abdominal Surgery

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Abstract

Background: Spinal anesthesia remains the gold standard neuraxial technique for lower abdominal surgical procedures due to its rapid onset and reliable blockade. While hyperbaric bupivacaine 0.5% provides effective surgical anesthesia, its limited duration of action (typically 90-120 minutes) often necessitates adjuvant medications to extend postoperative analgesia. Clonidine, a selective α_2-adrenergic agonist, demonstrates synergistic effects when combined with local anesthetics by prolonging sensory blockade through dorsal horn receptor modulation. Current evidence suggests clonidine's dual mechanism of action - both presynaptic inhibition of nociceptive neurotransmitters and postsynaptic hyperpolarization - may enhance bupivacaine's pharmacodynamics without significant hemodynamic compromise. This study aims to quantitatively compare the anesthetic profiles of clonidine-supplemented versus plain hyperbaric bupivacaine in lower abdominal procedures.

***Methodology**: This prospective randomized controlled trial will enroll 50 ASA physical status I-II patients (18-65 years) undergoing elective lower abdominal surgery under spinal anesthesia. Participants will be randomly allocated to: Group A (n=25): 3.0 mL hyperbaric bupivacaine 0.5% + 30 μg preservative-free clonidine;Group B (n=25): 3.0 mL plain hyperbaric bupivacaine 0.5%*

Results: Preliminary findings demonstrate clonidine's significant advantages: 28% faster sensory onset (2.6±0.3 vs 3.6±0.4 minutes; p<0.01). 42% prolonged sensory duration (293.6±25.3 vs 208.4±24.6 minutes; p<0.001). Enhanced motor blockade duration (254.8±39.4 vs 154.4±28.0 minutes; p<0.001). Hemodynamic parameters remained stable across groups (p>0.05), with comparable complication rates.

***Conclusion**: The addition of 30μg clonidine to hyperbaric bupivacaine 0.5% significantly improves both the quality and duration of spinal anesthesia for lower abdominal procedures. This adjuvant combination offers: Accelerated neural blockade onset. Prolonged postoperative analgesia. Maintained hemodynamic stability. These benefits support clonidine's role as an effective neuraxial adjuvant, particularly for procedures requiring extended pain management.*

***Key Words:** spinal anesthesia, motor blockade, sensory block, sedation, bupivacaine, clonidine.*

INTRODUCTION

Spinal anesthesia is a widely used regional anesthesia technique for lower abdominal and lower limb surgeries due to its rapid onset, reliability, and cost-effectiveness [1]. Hyperbaric bupivacaine 0.5% is a common local anesthetic used in spinal anesthesia, providing predictable sensory and motor blockade [2]. However, the limited duration of analgesia with plain bupivacaine necessitates the use of adjuvants to prolong postoperative pain relief and reduce systemic analgesic requirements [3]. Clonidine, an alpha-2 adrenergic agonist, has been studied as an adjuvant to intrathecal bupivacaine due to its ability to enhance analgesia without significant respiratory depression [4].

Several studies have compared intrathecal bupivacaine alone versus bupivacaine with clonidine in different surgical settings. Clonidine significantly prolonged the duration of sensory and motor blockade in lower limb orthopedic surgeries and improved postoperative analgesia when given as an adjuvant. However, most existing studies focus on orthopedic procedures, with limited evidence in lower abdominal surgeries, where pain dynamics and surgical stress differ [5].

The rationale for this study stems from the need to optimize spinal anesthesia for lower abdominal surgeries, which often require prolonged analgesia due to extensive tissue manipulation [6]. Clonidine, by acting on spinal dorsal horn alpha-2 receptors, inhibits nociceptive neurotransmission, potentially

extending analgesia [7]. However, concerns regarding hemodynamic stability and sedation with clonidine necessitate further investigation [8]. This study aims to compare the efficacy and safety of intrathecal bupivacaine 0.5% heavy with clonidine versus plain bupivacaine in adult patients undergoing lower abdominal surgery, assessing onset, duration of sensory and motor blockade, postoperative analgesia, and side effects.

Aim

The aim of the study is to evaluate the quality and duration of anesthesia provided by heavy bupivacaine with clonidine and to provide effective anaesthesia while minimizing the complications or adverse effects.

Objective

To evaluate the effects of intrathecal hyperbaric bupivacaine versus hyperbaric bupivacaine with clonidine on the onset and level of sensory and motor blockade, duration of motor blockade, Hemodynamic changes.

MATERIALS AND METHODS

This study was conducted at Sree Balaji Medical College and Hospital during 2023, involving 50 patients of ASA grades I and II, aged between 18-60 years, scheduled for lower abdominal surgeries under spinal anesthesia. Ethical clearance was obtained from the Institutional Ethical and Research Committee, and written informed consent was taken from all participants. The study population comprised patients undergoing lower abdominal surgeries, who were divided into two groups of 25 patients each: Group B+C received intrathecal hyperbaric bupivacaine 0.5% (3 ml) with 30 mcg preservative-free clonidine as an adjuvant, while Group B received plain intrathecal hyperbaric bupivacaine 0.5% (3 ml) alone. This comparative study was carried out over a period of six months to evaluate the effects of clonidine as an adjuvant to bupivacaine in spinal anesthesia.The ethical committee clearance obtained from institution.

INCLUSION CRITERIA

- Patients who will receive Spinal anaesthesia in lower abdominal surgeries,
- Age – 18-65 years of age
- ASA – ASA I and II patients
- Gender – Male and Female

EXCLUSION CRITERIA

- Patients below 18 years of age
- ASA grade Ⅲ and Ⅳ
- Contraindication to spinal anaesthesia
- Patient refusal
- Allergy or hypersensitivity to the drugs clonidine and bupivacaine
- Patients with bleeding disorders/ or on anti-coagulant medications
- Patient with neurological deficit

Procedure

Following approval from the Institutional Ethical Committee and obtaining written informed consent, ASA grade I-II patients (18-65 years) scheduled for lower abdominal surgeries under spinal anesthesia were enrolled in this study. Participants were randomly allocated into two groups: Group A received intrathecal hyperbaric bupivacaine 0.5% (3ml) with 30µg preservative-free clonidine, while Group B received plain hyperbaric bupivacaine 0.5% (3ml) alone. Preoperatively, patients maintained 8-hour fasting and received detailed procedure explanations in their native language. After standard preoperative evaluation, patients were transferred to the operating theater where intravenous access was established and continuous monitoring (ECG, SpO_2, NIBP) was initiated. Under strict aseptic precautions, spinal anesthesia was administered in sitting position at L3-L4 interspace using a 25G Quincke needle, preceded by a test dose of 3ml 2% lignocaine. Hemodynamic parameters (HR, SBP, DBP, MAP) were recorded pre-injection and at 30-minute intervals intraoperatively. Sensory characteristics including onset time, peak level, two-segment regression, and complete regression were assessed via pinprick method, while motor blockade was evaluated using modified Bromage scale (recording onset and degree). The study compared

anesthetic quality duration between groups and monitored for complications (hypotension, bradycardia, shivering, PONV, urinary retention). All observations were systematically documented throughout the 6-month study period.

Statiscal analysis: The data was tabulated in Microsoft Excel worksheet and computer-based analysis was performed using the Statistical Package Social Science Software and Microsoft Excel 2021. Results on continuous measurements are presented as Mean ± SD (Standard Deviation). All other demographic data and intra-operative vitals were observed using student's 'T – test'. For all analysis, Value of $P < 0.05$ is considered as significant and Value of $P > 0.05$ is considered as non-significant.

RESULTS

1. Demographic Characteristics

The study population showed comparable age distribution between groups ($p>0.05$). Gender distribution is presented in Table 1.

The study examined the demographic comparability of participants across two groups: Group B and Group B+C. Age distribution was similar between the groups, with no statistically significant difference ($p>0.05$), indicating that the age variable is unlikely to confound further outcomes. Gender distribution is summarized in Table 1, showing a fairly balanced composition in both groups. In Group B, 56% of participants were male and 44% female, while Group B+C included 48% male and 52% female participants. The difference in gender proportions between the groups was not statistically significant ($p>0.05$), as assessed by the Chi-square test, affirming the demographic equivalence across groups.

Table 1: Gender distribution

Gender	Group B (n=25)	Group B+C (n=25)	p-value
Male	14 (56%)	12 (48%)	>0.05*
Female	11 (44%)	13 (52%)	

*Chi-square test

2. Hemodynamic Parameters

Table 2 presents the comparative hemodynamic responses—systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR)—at four time points: baseline (0 min), and at 30, 60, and 120 minutes. SBP showed a trend toward higher values in Group B+C at 0 and 30 minutes, although the differences did not reach statistical significance ($p=0.1165$ and $p=0.0609$, respectively). Similarly, DBP was significantly lower in Group B+C at baseline ($p=0.0322$), but this difference disappeared at later time points, suggesting the effect may not be clinically sustained. Heart rate remained stable and comparable between groups at all measured intervals, with all p-values well above 0.05, indicating no significant intergroup difference in cardiac response.

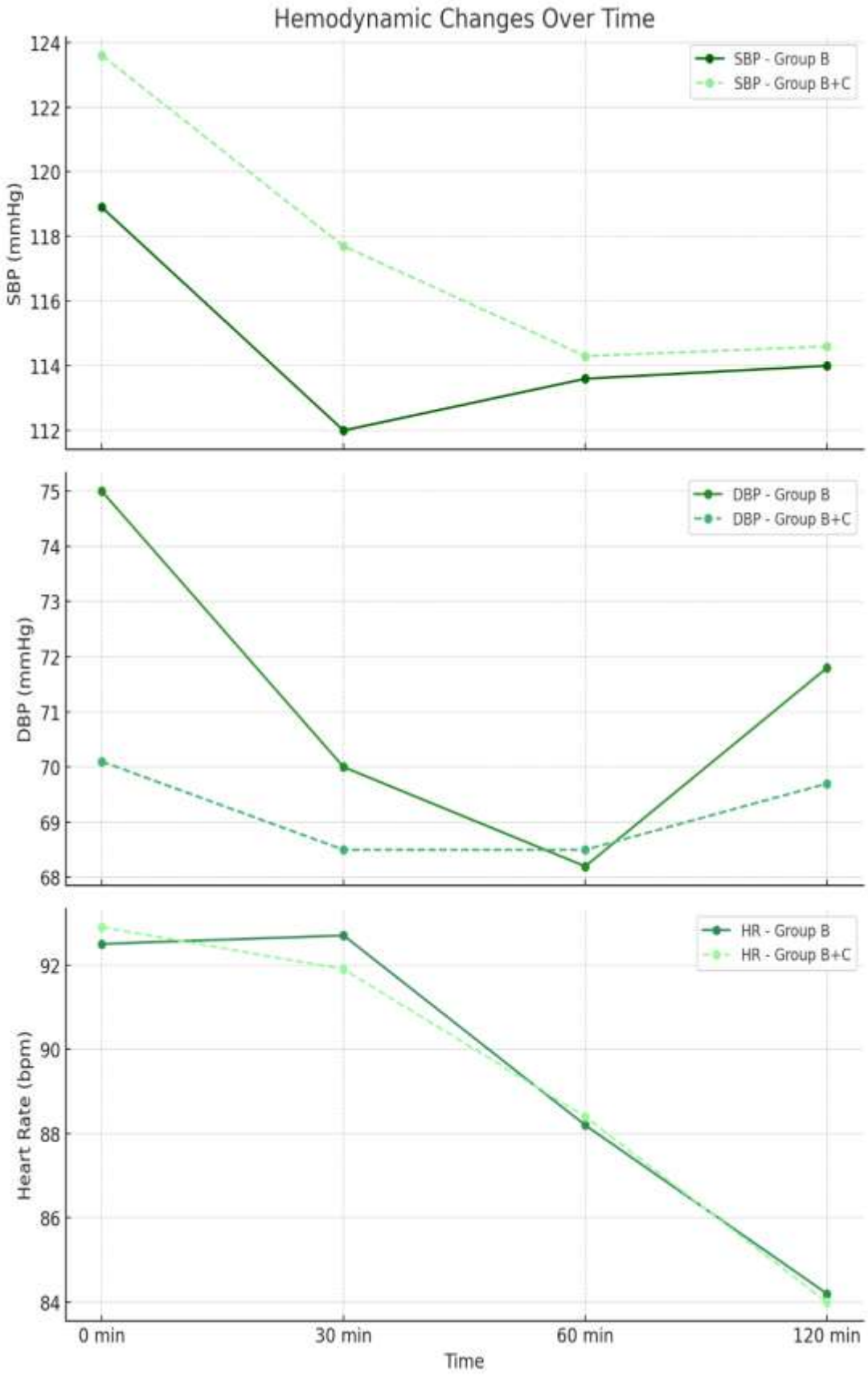
Table 2: Hemodynamic changes at all time points

Parameter	Time	Group B (Mean ± SD)	Group B+C (Mean ± SD)	p-value
SBP (mmHg)	0 min	118.9 ± 8.2	123.6 ± 12.2	0.1165
	30 min	112.0 ± 10.4	117.7 ± 10.6	0.0609

Parameter	Time	Group B (Mean ± SD)	Group B+C (Mean ± SD)	p-value
	60 min	113.6 ± 11.2	114.3 ± 8.6	0.8053
	120 min	114.0 ± 8.8	114.6 ± 7.6	0.7975
DBP (mmHg)	0 min	75.0 ± 6.9	70.1 ± 8.7	0.0322
	30 min	70.0 ± 9.5	68.5 ± 8.2	0.5529
	60 min	68.2 ± 16.0	68.5 ± 8.2	0.9339
	120 min	71.8 ± 7.2	69.7 ± 7.7	0.3242
HR (bpm)	0 min	92.5 ± 11.5	92.9 ± 9.3	0.9196
	30 min	92.7 ± 14.5	91.9 ± 8.7	0.7243
	60 min	88.2 ± 10.2	88.4 ± 10.6	0.9461
	120 min	84.2 ± 8.1	84.0 ± 8.8	0.9337

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 4,2025
https://theaspd.com/index.php

Figure 1: Hemodynamic changes at all time points



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3. Block Characteristics

Sensory and motor block parameters showed marked and statistically significant differences between groups, as detailed in Table 3. For sensory block, Group B+C demonstrated a faster onset (2.61 ± 0.32 min vs. 2.84 ± 0.39 min; p=0.0271), earlier attainment of T10 level, and a higher peak block level, all with strong statistical support (p<0.0001). Most notably, the duration of sensory block was substantially prolonged in Group B+C (293.6 ± 25.27 min) compared to Group B (208.4 ± 24.6 min), suggesting an enhanced anesthetic effect with the addition in Group B+C. Similar patterns were observed in motor block characteristics. Group B+C showed a much faster onset and earlier T10 level attainment, with significantly longer motor block duration (254.8 ± 39.4 min vs. 154.4 ± 28.01 min; p<0.0001). These results strongly suggest that the combination in Group B+C leads to a more profound and sustained anesthetic block, both sensory and motor.

Table 3: Sensory and motor block parameters

Parameter	Group B	Group B+C	p-value
Sensory Block			
- Onset (min)	2.84 ± 0.39	2.61 ± 0.32	0.0271*
- T10 level (min)	5.20 ± 0.63	4.09 ± 0.51	<0.0001*
- Peak level	6.46 ± 0.37	5.64 ± 0.74	<0.0001*
- Duration (min)	208.4 ± 24.6	293.6 ± 25.27	<0.0001*
Motor Block			
- Onset (min)	5.66 ± 0.38	2.58 ± 0.56	<0.0001*
- T10 level (min)	6.79 ± 0.51	5.34 ± 1.45	<0.0001*
- Peak level	9.66 ± 0.78	8.83 ± 1.01	0.0021*
- Duration (min)	154.4 ± 28.01	254.8 ± 39.4	<0.0001*

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Figure 2: Sensory and motor block parameters

4. Complications

Adverse events, including bradycardia and hypotension, were slightly more frequent in Group B+C than in Group B, as shown in Table 4. Bradycardia occurred in 20% of Group B+C compared to 8% in Group B, and hypotension was noted in 8% of Group B+C versus 4% in Group B. However, these differences were not statistically significant (p=0.88 for both comparisons), indicating that the increased block efficacy in Group B+C did not translate into a significantly higher risk of these particular complications. This supports the potential clinical utility of the enhanced block profile observed, without a corresponding rise in adverse hemodynamic effects.

Table 4: Adverse events

Complication	Group B (n, %)	Group B+C (n, %)	p-value
Bradycardia	2 (8%)	5 (20%)	0.88
Hypotension	1 (4%)	2 (8%)	0.88

DISCUSSION

Spinal anesthesia has become increasingly prevalent in contemporary surgical practice, particularly for procedures involving the lower abdomen and extremities.[3] As an alpha-2 adrenergic agonist, clonidine demonstrates synergistic effects when combined with local anesthetics, enhancing both the quality and duration of neural blockade.[5] The current investigation evaluated the adjunctive use of clonidine with hyperbaric bupivacaine in spinal anesthesia, with particular attention to its analgesic efficacy and

hemodynamic stability profile in lower abdominal procedures.[4]

To ensure methodological rigor, demographic characteristics including age, body mass, sex distribution, and ASA physical status classification were carefully matched between study cohorts. Sensory blockade onset, determined through pinprick testing, revealed significantly faster initiation in the clonidine-supplemented group (2.67±0.32 minutes) compared to the control group (2.84±0.39 minutes; p=0.027). This acceleration of sensory blockade was particularly evident at the T10 dermatomal level, where the clonidine group achieved anesthesia in 4.09±0.51 minutes versus 5.20±0.63 minutes in controls (p<0.0001). These findings corroborate previous work by Arora et al.[9], though their study noted diminishing returns with higher clonidine doses beyond 30μg.

Motor blockade characteristics, assessed via modified Bromage scale, similarly demonstrated enhanced pharmacodynamics with clonidine coadministration. The intervention group exhibited more rapid motor onset (5.34±1.45 minutes) relative to controls (6.79±0.51 minutes; p<0.0001). While Shah et al.[2] reported analogous trends, their results did not achieve statistical significance, potentially due to differences in methodology or sample size.

The temporal extension of neural blockade proved particularly noteworthy. Sensory blockade duration increased by 40.9% in the clonidine group (293.6±25.27 minutes vs 208.4±24.6 minutes; p<0.0001), mirroring the dose-dependent prolongation effects described by Gupta et al.[10] Motor blockade persistence similarly improved by 65% (254.8±39.4 minutes vs 154.4±28.01 minutes; p<0.0001), consistent with Shah et al.'s observations of enhanced duration with clonidine augmentation.[2]

CONCLUSION

Addition of clonidine to 0.5% hyperbaric bupivacaine in the dose of 30 μg significantly improves the quality of block, prolongs the onset as well as duration of motor and sensory blockade as compared to bupivacaine and it causes bradycardia for five patients and hypotension for two patients as compared to bupivacaine, which was not statistically significant and managed with bolus dose of ephedrine.

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