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Original Research Article

Comparative study of different doses of intrathecal clonidine as an adjuvant to bupivacaine for lower limb surgeries: A prospective observational study

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ABSTRACT

Background and Aim: Clinical studies suggested that intrathecal clonidine as an adjuvant to hyperbaric bupivacaine prolongs sensory as well as the motor block of spinal anesthesia, decreases local anesthetic drug requirement, and provides postoperative analgesia. In the present study, we have examined the effects of two distinct clonidine dosages administered intrathecally as an adjuvant to hyperbaric bupivacaine in individuals undergoing elective lower limb operations, to find out the optimal dose among them.

Materials and Methods: Two groups of thirty patients each posted for lower limb surgery were included in this study. Patients in Group A Received inj. bupivacaine (hyperbaric) 0.5% 3ml (15 mg) + inj. clonidine 0.2 ml (30 μg) + normal saline 0.1 ml intrathecally, in Group B patients received inj. bupivacaine (hyperbaric) 0.5% 3ml (15 mg) + inj.clonidine 0.3 ml (45 μg) intrathecally. Throughout spinal anesthesia; both groups were prospectively observed for various parameters.

Results: Compared to patients in group A, patients in group B experienced sensory and motor block for longer durations of time. As compared to group A patients, group B patients experienced increased hypotension, bradycardia, and dry mouth; however, overall adverse effects are mild and easily treated. In addition, we observed that group B patients experienced analgesia for a longer duration of time than did Group A patients.

Conclusion: Addition of intrathecal clonidine to bupivacaine significantly hastens the onset of sensory and motor block, provides excellent surgical analgesia, prolongs the duration of superior quality postoperative analgesia and reduced postoperative analgesic requirements with relative hemodynamic stability.

1. Introduction

Spinal anesthesia has increasingly become the technique of choice for lower limb surgeries to provide adequate surgical anesthesia and analgesia because it is simple to use with no systemic and local anesthetic toxicity and reliability in producing uniform sensory and motor block in awake patients, better suppression of neuroendocrine stress response, prevents the risk of aspiration of gastric contents and continues analgesia in the postoperative period.[1]

Hyperbaric Bupivacaine is the most commonly used local anesthetic drug for subarachnoid block because of less neurotoxicity. Various intrathecal adjuvants like adrenaline, ketamine, midazolam, neostigmine, clonidine, and opioids have been tried with local anesthetic agents in spinal anesthesia to prolong its duration of action and provide postoperative analgesia.[2]

Clonidine was first tried intrathecally by Gordh in 1983.[3] Clinical studies suggested that intrathecal clonidine as an adjuvant to hyperbaric bupivacaine prolongs sensory as well

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as the motor block of spinal anesthesia, decreases local anesthetic drug requirement, and provides postoperative analgesia. Other effects of clonidine are antiemesis, reduced post-spinal shivering, anxiolysis, and sedation.[4,5]

The purpose of the current study was to determine the most effective dose for elective lower limb surgeries by comparing the effects of two different clonidine doses (30 μg and 45 μg) added intrathecally to 0.5% hyperbaric bupivacaine 3 ml (15 mg). (30 patients in each group). The study aims to compare many aspects such as the onset, duration, perioperative hemodynamic changes, length of post-operative analgesia, perioperative sedation, and problems related to sensory and motor block.

2. Materials and Methods

This study was a prospective comparative observational one, with written informed consent obtained, and sixty patients, aged twenty to sixty years both males and females who were all posted for elective lower limb surgeries under spinal anesthesia and were having an American Society of Anesthesiologists (ASA) grade I or II. The study was granted authorization from the Institutional Review Board.

Based on the study by Mebazaa MS et al,[6] 30 patients in each group were required (α = 0.05 and β = 0.20). We enrolled 30 patients in each Group and they were divided into two groups by randomisation. Patients in Group A received inj. bupivacaine (hyperbaric) 0.5% 3ml (15 mg) + inj. clonidine 0.2 ml (30 μg) + normal saline 0.1 ml intrathecally, in Group B patients received inj. bupivacaine (hyperbaric) 0.5% 3ml (15 mg) + inj.clonidine 0.3 ml (45 μg) intrathecally.

A sample size of 30 patients in each group was selected to achieve a power of 80% and accepting an α error of 0.05, to be able to detect a difference of at least 50 min in the mean time of analgesic request in clonidine groups. The total volume of the drug was 3.3 ml in both groups.

The drugs used intrathecally were preservative-free. These solutions were prepared by an anesthesiologist not involved in the patient's care.

Patients with a history of allergy to study drugs, history of psychiatric illness, having any spinal deformity, infection on back, bleeding disorders, patients on anticoagulant therapy or having any other contraindications to spinal anesthesia, Patients who were pregnant, had renal or hepatic impairment, were contraindicated for spinal anesthesia, or refused to participate in the study were excluded from it.

Under all strict aseptic and antiseptic precautions, with the patient in a sitting/left lateral position depending upon surgery and the patient's comfort, A 23-gauge Quincke's spinal needle was used by the anesthetist to perform a lumbar puncture at the L3-L4 intervertebral area using a midline/ paramedian approach. The medication was administered gradually following a clear and uninterrupted flow of CSF. The time of subarachnoid injection of the drug was noted and considered as 0 minutes. Patients were then turned to a supine position.

Pulse, BP, RR, and SpO2 were recorded every 5 minutes till the first half an hour then every 15 minutes till 1st hour, at every 30 minutes for up to 5 hours, and then hourly for up to 12 hours.

2.1. Evaluation

2.1.1. Sensory block

The 24-gauge blunt needle was used to measure the degree of sensory block, which was noted as a loss of sensation to pin prick. The time it took to reach sensory level at T10 dermatome following subarachnoid injection was documented as the onset of sensory block. The maximum degree of sensory block was evaluated and recorded. The length of the sensory block (the amount of time it took to recede to the S2 dermatome from the beginning) was observed.

2.1.2. Motor block

The motor block was assessed by a modified Bromage scale[7] as follows: 0: There is no motor block. 1: capable of moving knees and feet but unable to elevate an extended leg. 2: The capacity to move the feet but not the knee when lifting an extended leg. 3: Full-limb motor block. It was documented when the motor block started (the amount of time needed to reach a score of 3 on the modified Bromage scale for motor block following subarachnoid injection). It was observed how long the motor block lasted (how long it took for the motor block to regress from score 3 to score 0).

Patients were assessed for degree of alertness/sedation & scoring was done by using the Campbell sedation score[8] as follows: 1: Wide awake. 2: Awake and comfortable. 3: Drowsy and difficult to arouse.4: Not arousable. Patients were inquired postoperatively about the degree of pain they felt with the help of a visual analog scale (VAS), which ranges from no pain (0) to the worst pain (10), and the time for the demand for analgesia was noted. The first dose of rescue analgesic was given to the patient when the VAS score was $\geq$ 4. An injection of Diclofenac 75 mg intravenously was administered as a pain reliever. The length of the analgesic and the time until the first dose of the rescue medication were recorded.

2.2. Statistical analysis

Version 21.0 of the Statistical Package for Social Sciences (SPSS) was used to analyze the data. The information gathered was the mean ± standard deviation (SD) and percentages were computed, compared using the unpaired t-test, and statistical analysis was performed. A P-value of less than 0.05 is considered significant.

3. Results

The present study was observed on 60 patients aged 20-60 years of either gender with ASA grade I or II posted for elective lower limb surgeries under spinal anesthesia.

Table 1: Demographic characteristics [Mean±SD]

Variables		Group A (BC30)	Group (BC45)
No. of patients		30	30
Age (years)		34.4±11.1	35.1±10.8
Gender (Male/Female)		15/15	16/14
Height (cms)		170±3.52	170±3.26
Weight (kgs)		68±5.3	69±5.1
ASA Grade	I	16	15
	II	14	15

BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

There were no intergroup differences as regards to the demographic profile and ASA physical status of patients enrolled in our study. The mean age of patients in Group A was 34.04 ± 11.1, in Group B was 35.1 ± 10.8. The mean weight of patients in Group A was 68 ± 5.3, in Group B was 69 ± 5.1. There were 15 male and 15 female in Group A, 16 males and 14 females in Group B (Table 1)

Table 2: Pre-operative hemodynamic parameters [Mean±SD]

Characteristics	Group A (BC30)	Group B (BC45)	p-value	Inference
Pulse (/min)	86.3±8.62	84.3±10.2	0.41	NS
Blood pressure (mmHg) at the Systolic level	127±9.04	126±9.51	0.44	NS
Blood pressure (mmHg) at the Diastolic level	82.9±6.05	80.7±6.31	0.17	NS
Mean arterial pressure (mmHg)	97.71±6.24	95.6±6.47	0.21	NS
SpO2 (%)	98.4±0.67	98.2±0.68	0.45	NS

[NS- Not Significant]
BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg+Clonidine 45μg

There were no significant differences between the three groups regarding preoperative HR, SBP, and DBP, RR, and oxygen saturation. (Table 2)

The mean duration of sensory block was significantly prolonged in Group B, with Group A having 141.8 ± 24.69 min and 142.7 ± 23.66 in Group B. (Table 3)

Table 3: Duration of surgery [Mean±SD]

	Group A (BC30)	Group B (BC45)	p-value	Inference
Duration (mins)	141.8±24.69	142.7±23.66	0.89	NS

NS-Not Significant
BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

Table 4 indicates that there was no significant difference ($p > 0.05$) at the start of the sensory block between the two groups. T8 was the highest sensorydermatomal level attained in both groups. Individuals in Group B had longer sensory block duration than individuals in Group A. A statistically significant difference was observed ($p < 0.0001$).

Table 5 demonstrates that there was a statistically insignificant difference (p 0.05) in the onset of the motor block between the two groups. Individuals in Group B experienced longer motor block duration than individuals in Group A. There was a statistically significant difference (p 0.0001).

As shown in Table 6, there was statistically no significant difference in HR did not significantly change between the two groups ($p < 0.05$) for up to 15 minutes following subarachnoid injection. From the thirty minutes to the hour, there was a statistically significant decrease in HR in Group B patients as compared to Group A patients ($p < 0.05$). After that, there was statistically no significant difference in HR among both groups ($p > 0.05$).

As shown in Table 7, there was statistically no significant difference in MAP levels in both groups and did not differ significantly (p 0.05) until 15 minutes following subarachnoid injection. Between 30 minutes and one hour, there was a statistically significant decrease of MAP in Group B patients as compared to Group A patients ($p < 0.05$). After that, there was statistically no significant difference in MAP among both groups ($p > 0.05$).

Table 8 compares perioperative complications among both groups. Hypotension and bradycardia were more in Group B patients as compared to Group A patients. Patients in Group B experienced higher cases of dry mouth than patients in Group A.

In Group A intraoperative, 12 patients (40%) were wide awake while 18 patients (60%) were awake and comfortable. In Group B intraoperatively, 8 patients (26.66%) were wide awake, 21 patients (69.99%) were awake and comfortable while 1 patient (3.33%) was drowsy and difficult to arouse. The total duration of analgesia was higher in Group B patients (390.5±15.44) as compared to Group A patients (327.9±14.67), which was statistically highly significant ($p < 0.0001$).(Graph 1)

Table 4: Characteristics of sensory block [Mean±SD]

	Group A (BC30)	Group B (BC45)	p-value	Inference
Onset of sensory block (mins) (Time required to achieve sensory level at T10 dermatome from time of subarachnoid injection).	4.43±0.85	4.83±0.79	0.06	
Duration of sensory block (mins) (Time for regression of sensory block to S2 dermatome from onset).	242.83±10.8	281±19.80	<0.0001	HS

NS-Not Significant, HS-Highly Significant
BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

Table 5: Characteristics of motor block [Mean±SD]

	Group A (BC30)	Group (BC45)	p-value	Inference
Onset of motor block (mins)	9.36±0.76	9.66±1.37	0.3	NS
Duration of motor block (mins)	213.63±10.24	250.5±20.05	<0.0001	HS

NS- Not Significant, HS- Highly Significant
BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

Table 6: Perioperative heart rate [Mean±SD]

Perioperative heart rate (/min)				
Duration	**Group A (BC30)**	**Group (BC45)**	**p-value**	**Significance**
0 min	89.6±7.89	87.8±9.75	0.43	NS
5 mins	88.9±8.86	88.2±9.44	0.78	NS
10 mins	85.53±6.98	85.93±9.53	0.85	NS
15 mins	83±6.4	85±8.3	0.2	NS
30 mins	80±6	76±7.9	0.031	S
1 hr	77±3.7	74±7.2	0.04	S
1.5 hrs	79±3.8	79±7.8	0.6	NS
2 hrs	80±3.9	78±7.6	0.1	NS
4 hrs	82.6±4.85	83.9±8.62	0.46	NS
6 hrs	85.53±4.59	84.9±10.2	0.77	NS
8 hrs	85.3±5.39	84.5±9.51	0.69	NS
10 hrs	84.7±4.74	83.73±9.32	0.63	NS
12 hrs	82.67±4.93	84.33±8.77	0.36	NS

NS- Not Significant, S- Significant
BC30= Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

Table 7: Perioperative mean arterial blood pressure [Mean±SD]

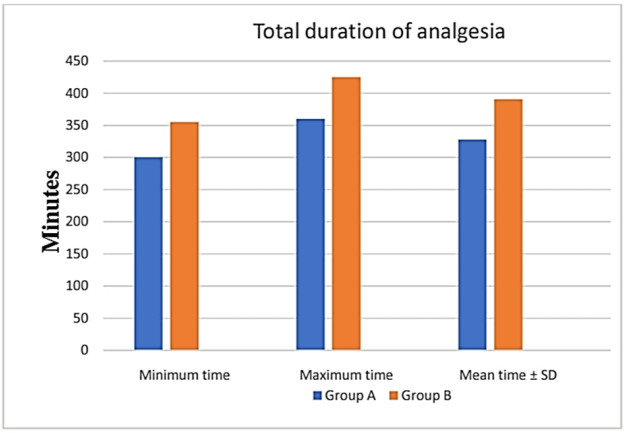
Duration	Group A (BC30)	Group (BC45)	p-value	Significance
0 min	101±4.11	98.8±6.11	0.18	NS
5 mins	98±3.4	96±5.4	0.2	NS
10 mins	93.1±4.4	92.6±5.17	0.69	NS
15 mins	90.1±3.91	91±4.88	0.41	NS
30 mins	89.7±3.45	86.2±5.1	0.002	S
1 hr	86±4.15	81.4±7.31	0.0040	S
1.5 hrs	88.6±3.87	85.8±7.31	0.07	NS
2 hrs	90±4.2	90±6.4	1	NS
4 hrs	93.8±4.16	93.8±6.16	0.99	NS
6 hrs	95.5±4.00	93.5±5.86	0.13	NS
8 hrs	95.7±3.90	93.9±7.27	0.23	NS
10 hrs	96.6±3.41	94.2±6.35	0.07	NS
12 hrs	95.8±3.46	93.5±5.86	0.07	NS

NS- Not Significant, S- Significant
BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg

Table 8: Perioperative complications

Complications	No. of Patients			
	Group A (BC30)		Group (BC45)	
	Intra-op	Post-op	Intra-op	Post-op
Hypotension	1(3.33%)	0	3(10%)	0
Bradycardia	1(3.33%)	0	2(6.66%)	0
Dryness of mouth	1(3.33%)	0	2(6.66%)	0
Nausea/Vomiting	0	0	0	0
Respiratory depression	0	0	0	0
Shivering	0	0	0	0
Urinary retention	0	0	0	0

BC30 = Bupivacaine 15mg + Clonidine 30μg, BC45 = Bupivacaine 15mg + Clonidine 45μg



Graph 1: Total duration of analgesia in mins (Mean±SD)

4. Discussion

Effective treatment of pain represents an important component of postoperative recovery. It serves to blunt autonomic, somatic, and endocrine reflexes with a resultant potential decrease in perioperative morbidity. Despite advances in the treatment of postoperative pain, many patients still suffer from pain after surgery, probably due to difficulties in balancing postoperative analgesia with acceptable side effects. Lower limb surgeries are performed under spinal anesthesia, as it is easy to perform, single shot technique when compared to epidural and general anesthesia. However, its main drawback is that the analgesia is of limited duration. In recent years, clonidine which is a selective partial agonist for $\alpha 2$ adrenergic receptors has been used to prolong the duration of spinal anesthesia. It is more potent after neuraxial than systemic administration indicating the spinal site of action and favoring neuraxial administration.[8] Clonidine is known to block the conduction through A-Delta fibers. Intrathecal $\alpha 2$ agonists are found to have antinociceptive action for both somatic and visceral pain. In the present study, we have examined the effects of two distinct clonidine dosages administered intrathecally as an adjuvant to hyperbaric bupivacaine in individuals undergoing elective lower limb operations, to find out the optimal dose among them.

In this clinical trial, 60 patients aged 20-60 years of either gender with ASA grade I or II posted for elective lower limb surgeries under spinal anesthesia were included, and the demographic characteristics (age, gender, weight, height) and ASA grade were comparable among both the groups ($p > 0.05$).

Initial measurements of pulse, systolic and diastolic blood pressure, mean arterial pressure, respiratory rate, and SpO2 were all hemodynamically comparable for all patients in both groups ($p > 0.05$). Every patient in both groups had comparable total surgical durations ($p > 0.05$).

In our study, the onset of sensory block was 4.43±0.85 mins in Group A patients and 4.83±0.79 mins in Group B patients. Sasibhushan Guthikonda et al[1] (2016) in patients undergoing lower limb orthopedic procedures, three different dosages of clonidine (15 μg, 30 μg, and 45 μg) were evaluated as an adjuvant to hyperbaric bupivacaine. The time taken for the patients to reach the T8 sensory level was compared, and no difference was observed between the clonidine groups and the bupivacaine alone group.

Bhavini Shah et al. did a comparison of three doses of clonidine (15 μg, 30 μg, and 60 μg) added as an adjuvant to 2 ml of hyperbaric bupivacaine and could not find any dose-dependent variation at the beginning of the sensory block and the beginning of the peak sensory block in each group.[8] Our study's results with clonidine extended the duration of sensory block, which is similar to those of Sukhminder et al. and Sudipta Mandal et al. observed comparable prolongation of sensory blockade in clonidine groups.[9–11]

In our study, motor block onset was 9.36±0.76 mins in Group A patients and 9.66±1.37 mins in Group B patients. Similar to our study, Deepti Agarwal et al. tested the addition of a small dose of clonidine (15 μg and 30 μg) given intrathecally with 9 mg of hyperbaric bupivacaine and observed that Bromage grade 1 was achieved in all the patients in three groups with no significant difference among them.[12] Vivek T. Menacherry et al. evaluated the effect of the addition of two doses of clonidine (45 μg and

60 μg) to 2.75 ml (13.75mg) hyperbaric bupivacaine given intrathecally and discovered that there was no statistically significant difference among the groups regarding the mean time to onset of motor block.[13] Santosh T et alexamined the effects of combining two doses of clonidine (30 μg and 45 μg) with 12.5 mg of intrathecal hyperbaric bupivacaine in the lower limb and elective lower abdominal surgeries. The results showed that the duration of motor block was significantly extended in the groups receiving both 30 μg and 45 μg of clonidine, but more so in the group receiving 45 μg of clonidine.[14] Arora R et al evaluated the efficacy of two different doses of clonidine (15 μg and 30 μg) with 12.5 mg of hyperbaric bupivacaine in lower limb surgeries and observed that the 30 μg clonidine group's motor blockade duration (171.6±38.20 mins) was noticeably longer than that of the 15 μg clonidine Group Ind the control group.[15] In our investigation, we also found that the average length of the motor block was 213.63±10.24 minutes for patients in Group A and 250.5±20.05 minutes for patients in Group B. The duration of the motor block was higher in Group B patients as compared to Group A patients. Duration of motor block was prolonged in our study with clonidine which is comparable to the findings of Dobrydnjov.[16] Niemi observed comparable prolongation of motor blockade in clonidine groups.[17] However, duration of motor block prolongation was much higher in their study due to higher dose of clonidine (3 μg/kg) used by them. In a comparative study of dexmedetomidine and clonidine as an adjuvant to intrathecal bupivacaine in lower abdominal surgeries done by Ganesh M, and Krishnamurthy D, the mean sensory onset in Group C (clonidine 30 μg) was 1.4 ±0.5 min, and in Group D (dexmedetomidine 3 μg) was 1.2 ±0.4 min. This was found to be statistically significant and also quite fast in comparison to our study as they used the lesser doses.[18]

Santosh T et al. observed that the fall in pulse rate was significant but not less than 60/min requiring any intervention in either group except in one case in the 45 μg clonidine group where inj. atropine was required to treat it.[14] A similar observation was made in Group A (3.33%), and two patients in Group B (6.66%) were discovered to have bradycardia and needed to be treated with 0.6 mg of intravenous atropine. Three patients in Group B (10%) and one patient in Group A (3.33%) both experienced intraoperative hypotension and needed to be treated with injections of mephentermine (6 mg) intravenously. Clonidine after neuraxial or systemic administration affects arterial blood pressure in complex manner. The α2 adrenergic agonist produce sympatholysis and reduced arterial blood pressure by acting on specific brainstem nuclei and sympathetic preganglionic neurons in the spinal cord. On the other hand, α2 adrenergic agonist cause direct vasoconstriction by acting on the peripheral vasculature.[14,19]

One patient in Group A (3.33%) and two patients in Group B (6.66%) had dryness of mouth intraoperatively. None of the patients had episodes of nausea, vomiting, shivering, or urinary retention perioperatively. Similar findings were also reported in previous studies.[10,20]

A potential limitation of our study was that we did not observe dose-response relationship using various doses of clonidine intrathecally for postoperative analgesia.

5. Conclusion

Addition of intrathecal clonidine to bupivacaine even in very small doses significantly hastens the onset of sensory and motor block, provides excellent surgical analgesia, prolongs the duration of superior quality postoperative analgesia and reduced postoperative analgesic requirements with relative hemodynamic stability.

6. Sources of Funding

None.

7. Conflict of Interest

None.

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