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Original Research Paper

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EFFECT OF INTRATHECAL DEXMEDETOMIDINE AS AN ADJUVANT TO HYPERBARIC BUPIVACAINE IN ORTHOPAEDIC LOWER LIMB SURGERY: AN INTERVENTIONAL STUDY

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ABSTRACT **Background and Aims:** Neuraxial block is the preferred method of anaesthesia in lower limb surgery. Various adjuvants can be added to bupivacaine intrathecally to prolong the duration of spinal anaesthesia, decrease the local anaesthetics' dose requirement and increase the duration of post-operative analgesia. Dexmedetomidine is a selective alpha 2 adrenergic agonist used as an adjuvant. The aim of present study was to compare the effect of addition of dexmedetomidine to intrathecal bupivacaine for patients undergoing lower limb orthopaedic surgeries. **Methods:** The study was enrolled as prospective, randomised, interventional trial which included 50 patients of American society of Anaesthesiologists grade I and II scheduled for lower limb orthopaedic surgeries. Patients were allocated into 2 groups. Group A receiving hyperbaric bupivacaine alone and group B receiving hyperbaric bupivacaine with dexmedetomidine. The primary outcome of the study was to compare the duration of motor block and sensory regression to S1 between the two groups. The results were expressed as Mean ± standard deviation and compared between study groups by using the chi-squared test or Fisher's extract test. **Results:** Demographic data, time of onset of sensory block (p value 0.110) and onset of motor block (p value 0.450) were comparable between the two groups. Time of S1 regression of sensory block, duration of motor block, and post operative analgesia were significantly prolonged in dexmedetomidine group. **Conclusion:** Dexmedetomidine as an adjuvant had longer duration of sensory and motor block and longer post operative analgesia as compared to bupivacaine alone.

KEYWORDS : Spinal anaesthesia, Dexmedetomidine, adjuvants.

INTRODUCTION

Neuraxial block is routinely used method for lower limb surgeries. Neuraxial block is cost effective as it decreases the hospital stay, avoids the problems associated with airway management, reduces postoperative morbidity.

Traditionally amide and ester linked local anaesthetics have been used in regional anaesthetic techniques.[1] Hyperbaric bupivacaine is the most common intrathecally used local anaesthetic.[2] Various adjuvants can be added to hyperbaric bupivacaine to prolong the duration of spinal anaesthesia, decrease the local anaesthetics' dose requirement and increase the duration of post-operative analgesia.[3]

Dexmedetomidine is newer drug in this class which is highly selective alpha-2 adrenergic agonist with its $\alpha2/\alpha1$ selectivity eight times greater than that with clonidine[4] [5] It acts on both pre and post synaptic sympathetic nerve terminal and central nervous system thereby decreasing the sympathetic outflow and nor-epinephrine release causing sedative, analgesic, sympatholytic, anti-anxiety and haemodynamic effects.[6] [7]

The aim of present study was to find the effect of addition of dexmedetomidine to intrathecal bupivacaine for patients undergoing lower limb surgeries in terms of onset time of sensory and motor block, time of sensory regression to S1 and duration of motor block.

The primary outcome of the study was to compare the duration of motor block and sensory regression to S1 between the two groups. The secondary outcomes included comparison of onset of sensory and motor block, haemodynamic alterations and NRS (Numeric Rating Scale) 6 hours after surgery between the two groups.

METHODS

This prospective randomized interventional study was initiated after seeking clearance from Institutional Ethical Committee SNMC/IEC/2021/1423-1425 and Clinical Trial Registry (India) CTRI/2022/01/039100. In this interventional study, patients aged between 18 to 65 years of ASA (American Society of Anaesthesiologists) grade I and II of either sex scheduled for lower limb orthopaedic surgeries at Dr S.N. Medical College and associated group of hospitals in 2021 were included. Patients with absolute and relative contraindications of study drug, uncooperative patients, history of cardiac or respiratory diseases, hepatic failure, neuromuscular disorders were excluded from the study.

Sample size was calculated to be total 50 patients. Patients were randomly allocated into either of the two groups by a computer-generated random number table. Group A receiving Bupivacaine heavy (0.5%) 2.5 ml + 0.5ml normal saline and group B receiving Bupivacaine heavy (0.5%) 2.5ml + 5μg Dexmedetomidine in 0.5ml normal saline. All patients were instructed to remain nil per oral for 8 hours.

A written informed consent was taken from all the patients included in the study. After taking patient on operating table, all monitoring devices like electrocardiograph (ECG), pulse oximetry (SpO2), non-invasive blood pressure (NIBP) were attached. Base line blood pressure, pulse rate and oxygen saturation were recorded. Intravenous line secured with an 18 G cannula, preferably on the left dorsum of the hand and patient was given 10 mL/kg Ringer Lactate as preloading.

Patient positioned in the sitting position and after adequate aseptic precautions lumbar puncture was performed at L3/L4 or L2/L3 intervertebral space using midline approach with 25gauge Quincke spinal needle. After ensuring a free flow of

CSF, drug was injected. Then all patients were immediately placed in a supine position following the injection.

The onset of sensory block was assessed by loss of pin prick sensation over dorsum of foot[2]. Sensory regression to S1 was assessed by regain of pin prick sensation over heel of foot. Onset and duration of motor block was assessed by modified Bromage Scale[2]. Bromage 0-free movement of legs and feet, I- just able to flex knees with free movement of feet, II- unable to flex knees, but with free movement of feet, III- unable to move legs or feet. After surgery, assessment performed every 10 min until the time of regression to S1 sensory levels, then every 20 min until the regression time to Bromage 0. Sedation score was assessed by Modified Ramsay Sedation Scale[2] at the interval of 15 min intraoperatively and at 2 hours interval postoperatively. Postoperatively pain was assessed by NRS (Numeric Rating Scale)[8] 6 hours after surgery. The patients were asked to rate their pain from a scale 0 to 10 (where 0= no pain & 10= the worst possible pain).

The vital parameters such as NIBP, heart rate (HR) and SpO2 were monitored every 5 min interval for first 30 min after spinal anaesthesia, then monitoring done at the interval of 15 min till 2 hours. Postoperatively vitals were monitored at the interval of 2 hours. Hypotension was defined as a fall in systolic blood pressure of more than 20% of baseline value or less than 90 mmHg and was treated with volume expansion and if required, by incremental doses of mephentermine 3mg IV. Bradycardia was defined as fall in heart rate below 50 beats per minute and was treated with incremental doses of atropine 0.3 mg IV.

All data was analyzed using SPSS 26 (version 26; SPSS Inc., Chicago, IL). The results were expressed as Mean ± standard deviation or percentage. The study groups were compared by using the chi-squared test or Fisher's extract test. p-values of less than 0.05 was considered statistically significant.

RESULTS

All 50 patients of two groups completed the study without any exclusion. Patient demographic data that includes age, sex, and weight of patients between two groups were comparable (table 1).

Table 1: Demographic distribution between the two groups

Characteristics		Group A (n=25)	Group B (n=30)	P-value
Age (years)		37.12 ± 14.42	40.84 ± 17.27	0.303
Weight (kg)		62.80 ± 7.63	66.80 ± 9.88	0.116
Gender	Male	17(68%)	20 (80%)	0.333
	Female	8 (32)	5 (20%)	

Data represented as Mean ± SD, n- number of patients, SD- standard deviation

Table 2: Characteristics of block between the two groups

	Group A	Group B	p-value
Time of onset of Sensory block (min)	3.90 ± 0.66	3.55 ± 0.86	0.110
Time to achieve highest sensory level (min)	4.64 ± 0.52	4.41 ± 0.59	0.143
Time of Sensory regression to S1(min)	197.28 ± 31.84	500.40 ± 41.98	0.001
Time to achieve Modified Bromage 3 (min)	4.43 ± 0.71	4.26 ± 0.85	0.450
Duration of Motor Block (min)	165.96 ± 29.66	302.96 ± 53.66	0.0001

Data represented as Mean ± SD, n- number of patients, SD- standard deviation

Table 3: Highest level of Sensory block achieved

Highest level of sensory block achieved	Level	Group A		Group B		p-value
		No	%	No	%	
	T4	0	0	2	8	NA
	T5	3	12	8	32	0.523
	T6	10	40	10	40	1
	T7	8	32	4	16	0.571
	T8	4	16	1	4	0.779
		25	100	25	100	

Table 4: NRS 6 hours after surgery

NRS 6 hours after surgery	Group A		Group B		Total	p-value
	No.	%	No.	%		
1	0	0	8	32	8	0.0001
2	0	0	17	68	17	
5	9	36	0	0	9	
6	13	52	0	0	13	
7	3	12	0	0	3	
Total	25		25		50	

Table 5: Adverse effects

Adverse effects	Group A		Group B		P-value
	No	%	No	%	
No symptom	15	60	8	32	0.0002
Bradycardia	0	0	17	68	NA
Hypotension	7	28	0	0	NA
Shivering	3	12	0	0	NA
Total patients	25	100	25	100	

Characteristics of block between the two groups shown in table 2. The time of sensory regression to S1 was longer in group B (500.40 ± 41.98) as compared to group A (197.28 ± 31.84) (p value 0.001 < 0.05). The mean duration of motor block was prolonged in group B (302.96 ± 53.66) as compared to group A (165.96 ± 29.66) (p value 0.0001 < 0.05). In group A, 52% patients showed NRS 6 and 36 % patients showed NRS 5 whereas in group B, maximum patients (68%) showed NRS 2. On comparing both the groups, it was found to be statistically significant (p value 0.0001). This explains that patients in group B had good post operative analgesia.

The time of onset of sensory block and time to achieve Modified Bromage 3 were slower in group A as compared to group B, but results were not significant. The time to achieve highest sensory level was comparable between the two groups.

Highest sensory block achieved between the two groups shown in table 3. Highest level of sensory block achieved in group A was T5, whereas in group B highest level of sensory block achieved was T4. In group B, 32% patients achieved T5 level whereas in group A, 12% patients achieved T5 level. There was a difference between the 2 groups in no of patients achieved T5 but the difference was not significant. Table 5 depicts that in group A, 28 % patients experienced hypotension and 12% experienced shivering. While in group B, 68% patients experienced bradycardia.

Heart rate monitoring was done from preoperative basal to 6 hours postoperatively (figure 1). Heart rate was recorded in 16 time points, out of which 12 time points showed statistically significant difference. Mean arterial pressure was monitored from preoperative basal to 6 hours postoperatively (figure 2). None of the time points had statistically significant difference.

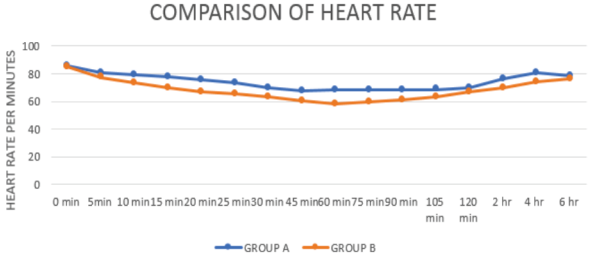

Figure 1: Intraoperative and Postoperative changes in Heart rate

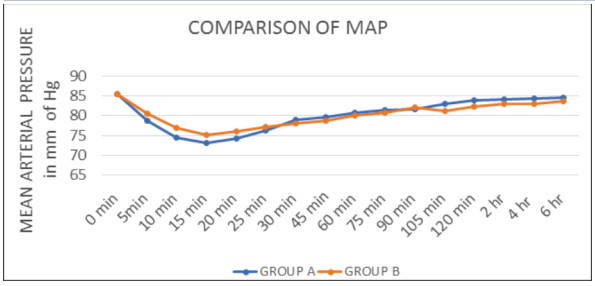

Figure 2: Intraoperative and Postoperative changes in Mean arterial pressure

DISCUSSION

In our study, we evaluated the efficacy of bupivacaine alone and bupivacaine with dexmedetomidine intrathecally in orthopaedic lower limb surgery. Dexmedetomidine is the dextrorotatory S-enantiomer of medetomidine which belongs to the imidazole subclass of α_2 receptor agonists. Locus ceruleus of the brain stem is the principal site for the sedative action and spinal cord is the principal site for the analgesic action of dexmedetomidine. Postsynaptic α_2 receptors in the peripheral blood vessels produce vasoconstriction, whereas α_2 receptors located in the presynaptic region inhibit the release of norepinephrine, potentially attenuating the vasoconstriction. These receptors are involved in the sympatholysis, sedation, and antinociceptive effects of α_2 receptors.

In our study, demographic data was comparable between the two groups. The time of onset of sensory block, time to achieve highest sensory block level and time to achieve Modified Bromage 3 were earlier in group B with results not significant. **Mahendru V. et al**[9] concluded that mean time of onset of sensory block was earlier in dexmedetomidine group as compared to bupivacaine group, with results not significant. Similarly, our results correlate with studies done by **Nayagam H. et al**[10], **Soori R. et al**[2] and **Mostafa M. et al**[12] with respect to onset of sensory block.

Rahimzadeh P. et al[8] concluded that mean time of onset of highest sensory level was earlier in dexmedetomidine group as compared to bupivacaine group, with results not significant. Likewise results obtained by **Kurhekar P. et al.**[13] **Rahimzadeh P. et al**[8] concluded that time to achieve Modified Bromage 3 was earlier in dexmedetomidine group as compared to bupivacaine group. Similar results obtained by **Dar F.A. et al**[5] and **Shukla U. et al**[11].

Maximum number of patients in group A as well as in group B achieved T6 level. Patients in group B achieved highest sensory block (T4) as compared to group A (T5). But results were not statistically significant. Similar results obtained by **Dar F. A. et al.**[5], **Rajan R. et al**[14] and **Khan A. et al.**[15]

The current study concluded that there was statistically significant difference with regards to time of sensory regression to S1 and duration of motor block. **Rahimzadeh P. et al**[8] concluded that mean time of sensory regression to S1 and duration of motor block was longer in dexmedetomidine group as compared to bupivacaine group, with statistically significant results. Similar results obtained by **Patro S. et al**[16], **Khan A. et al,**[15] **Santhi K. et al,**[1] **Gautam B. et al**[17] and **Tyagi A. et al.**[3]

Our study concluded that in group A, maximum patients experienced NRS 5 and 6. Whereas in group B, maximum patients experienced NRS 1 and 2 (p value < 0.05). This implies that dexmedetomidine group possess good post operative analgesia. Similar results obtained by **Rahimzadeh P. et al**[8] and **Patro S. et al.**[16]

In our study, systolic blood pressure, diastolic blood pressure, mean arterial pressure and SpO2 were comparable in both the groups. In group A, 28% patients developed hypotension and 12% developed shivering. Whereas in group B, 68% patients developed bradycardia. **Soori R. et al**[2] concluded significant results with respect to bradycardia as adverse effect in dexmedetomidine group.

Chattopadhyay I. et al[18] reported that dexmedetomidine added to low dose bupivacaine in TURP patients provides faster onset with prolonged duration of sensory and motor block and reduced analgesic requirements. Another study conducted by **Rahimzadeh P. et al**[8] concluded that, when dexmedetomidine added to bupivacaine intrathecally prolongs the duration of sensory and motor block with longer postoperative analgesia. Similarly, **Shukla U. et al**[11] concluded that dexmedetomidine when added to bupivacaine prolonged the duration of sensory and motor block with longer post operative analgesia.

Our study also has some limitations. In this study, we used a set dose (5 μg) of dexmedetomidine which may not be the optimal dose. The limitation could have been reduced if only one type of orthopaedic cases were included, to ensure uniformity in duration of surgery. Our study included patients of ASA grade I and II. Thus, the effect of intrathecal dexmedetomidine in older patients with comorbidities could not be assessed.

CONCLUSION

The present study concludes that 5 μg dexmedetomidine as an adjuvant to bupivacaine intrathecally in lower limb surgery prolonged the duration of sensory and motor block, longer post operative analgesia without significant haemodynamic alterations.

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