Section: Anaesthesia

Original Research Article

HYPERBARIC BUPIVACAINE VERSUS HYPERBARIC ROPIVACAINE WITH DEXMEDETOMIDINE IN SPINAL ANAESTHESIA FOR LOWER LIMB SURGERIES

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ABSTRACT

Background: Spinal anaesthesia is the most frequently utilised regional anaesthesia technique. The primary advantage of spinal anaesthesia is its relative simplicity, quickness, low failure rate, minimal side effects, and conscious patient. **Objective:** The key purpose of the study was to compare the effect of hyperbaric bupivacaine with dexmedetomidine and hyperbaric ropivacaine with dexmedetomidine in maintaining hemodynamic stability in the patients undergoing lower limb surgeries.

Materials and Methods: A prospective observational research project was performed in The Department of Anaesthesiology, GMC, Kottayam, on April 2022 to May 2023, in which 60 patients, (30 patients each group), ASA I and II, both sexes with age between 18-65 years undergoing lower limb surgeries where selected. After noting the baseline pulse, blood pressure, oxygen saturation, start of spinal time, 30 patients were given 0.5% Bupivacaine heavy 3ml + 6 mcg Dexmedetomidine by spinal anaesthesia under strict aseptic precautions. Data is analysed using SPSS version 25

Results: Compared the effects of bupivacaine and ropivacaine in lower limb surgeries with spinal anaesthesia which revealed that the duration of sensory block was shorter in the ropivacaine group than in the bupivacaine group. (132.5 min v/s 175.8 min; $P < 0.001$). Ropivacaine also demonstrated a shorter duration of motor block than bupivacaine (124.8 min vs 168.2 min; $P < 0.001$).

Conclusion: Both hyperbaric bupivacaine and hyperbaric ropivacaine are effective regional anaesthetic drugs for spinal anaesthesia. Moreover, addition of dexmedetomidine as an additive helps to increase the density and time taken for the spinal block; by potentiating the actions of local anaesthetics. It can be concluded that bupivacaine with dexmedetomidine is a better option for spinal anaesthesia for long duration lower limb orthopaedic and general surgical procedures.

Keywords: spinal anaesthesia, Bupivacaine, Ropivacaine, Dexmedetomidine, lower limb surgery.

INTRODUCTION

Spinal anaesthesia is the most commonly used regional anaesthesia technique.[1] Main advantage with spinal anaesthesia is its relative simplicity, rapidity, low failure rates, minimal side effects and an awake patient. It is safe and effective for both emergency and non-emergency surgeries involving lower abdomen and lower limbs. Main disadvantage is limited duration of action and lack of postoperative analgesia.

Hyperbaric bupivacaine is most commonly used local anaesthetic drug,[2] Bupivacaine is an Amide group of local anaesthetic that prevents local transmission of nerve impulse by inhibiting Sodium channels, Voltage dependent Potassium channels and type I Calcium channels.[3,4,5] For spinal anaesthesia 0.5%. Bupivacaine Heavy is used. It creates a significant and long-lasting sensory block.

For the past few years, newer local anaesthetic agents like Ropivacaine are also used for spinal anaesthesia. Ropivacaine, a long-acting Amide local anaesthetic, is a pure enantiomer.[6] Due to its low lipid solubility the penetration of large myelinated nerve fibres is less; with a preferential blockade of pain fibres (Aγ and C),[7] is seen compared to motor fibres (Aβ). This function is beneficial when a motor block is not desired. The cardiovascular and central nervous system toxicities are less likely to occur.

Dexmedetomidine is an alpha 2 adrenergic receptor agonist ten times more selective than clonidine.[6,7] It can promote sleepiness, relief from anxiety and discomfort in a dose-dependent manner (activity at the spinal and supraspinal levels), without producing respiratory depression. Dexmedetomidine enhances anaesthesia produced by other drugs; causes perioperative sympatholysis and decreases blood pressure by stimulating central α2 and imidazoline receptors. It has an analgesic; anaesthetic sparing effect; sympatholytic property; useful in procedural sedation. It lowers delirium, maintains respiratory function, and has cardiovascular stabilising properties.

MATERIALS AND METHODS

It was a Prospective Observational Study conducted for a period of 12 months from approval of Institutional Review Board. Study done in major operation theatre, Department of Anaesthesiology, Government medical College, Kottayam.

Sixty patients of either sex aged 18-65 years receiving lower limb surgeries under spinal anaesthesia in the surgical and orthopaedic department, Government Medical College, Kottayam, over the 12-month period following IRB approval.

A study by Alireza Olapour, Reza Akhandzedeh, and Manbobe Rashidi,[8] found that using Dexmedetomidine with Ropivacaine resulted in a mean duration of onset of sensory block of 2.32 +/- 0.9 minutes, while using Dexmedetomidine with Bupivacaine resulted in a mean duration of 1.28 +/- 0.4 minutes, which was statistically significant.

(P= < 0.001).

Sample size is calculated by the formula for comparison of two means n= $(Z\alpha+Z\beta)^2$ $(SD)^2$

M^2

SD= (SD 1^2 + SD 2^2)

M=M1-M2

Zα=1.98 (α error=5%)

Zβ=0.84 (β= 80%power)

M1 = 2.32

M2 =I.28

SD1= 0.9

SD 2 = 0.4

M = Mean

SD = Standard Deviation "n" was calculated to be 12.90 in each group, I have taken 30 patients.

Convenient sampling according to inclusion criteria till required sample size is achieved.

Study Tool

Structured Proforma

Modified Bromage scale

The Bromage Scale is a well acknowledged tool for measuring motor blocks. This scale determines the intensity of motor block based on the patient's ability to move their lower extremities.

1. Complete block [inability to move feet or knees].
2. Almost complete block [able to move feet only]
3. Partial block [merely able to move knees].
4. None [Able to perform full flexion of knees and feet]

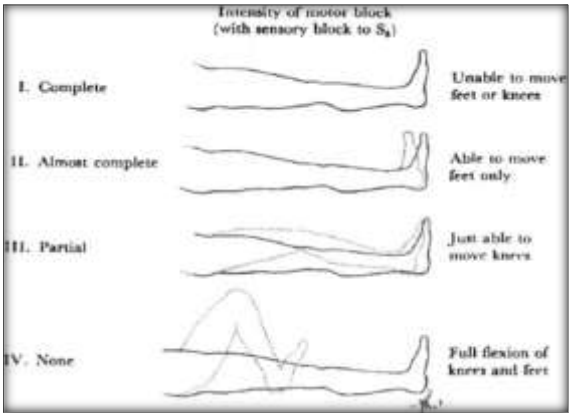

Figure 1: Modified Bromage scale

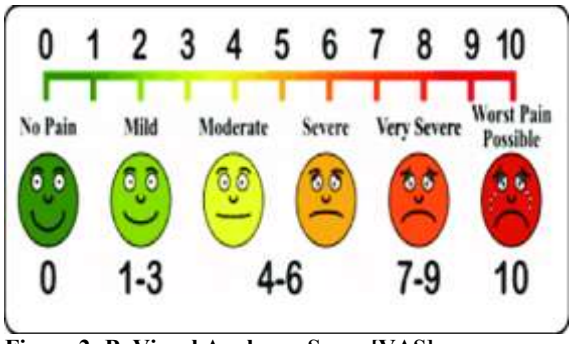

Figure 2: B. Visual Analogue Score [VAS]

Inclusion Criteria

- Patients of ages 18 to 65 years who belonged to ASA I and II came for lower limb operations.

Exclusion Criteria

- Patient refusal
- Patients with contraindications for spinal anaesthesia, such as elevated intracranial pressure, bleeding coagulopathy, and local infections.

Standard ASA monitors are attached to record heart rate, NIBP, continuous ECG monitoring, and oxygen saturation [SpO2]. Patients are positioned laterally, and under sterile conditions, lumbar subarachnoid block is administered after infiltration of local anaesthetics with a 25G Quinke needle at L3-4 levels via the midline method. Assessment of sensory and motor block is assessed after patient is turned to supine position.

The study population is then consecutively divided into two groups of 30 patients. First group – Group B (n=30) will receive 6 mcg Dexmedetomidine along with 3ml of 0.5%. Bupivacaine heavy. Second group – Group R (n = 30) will receive 6 mcg Dexmedetomidine along with 3ml of0.75%. Ropivacaine heavy A routine preanesthetic check-up is done on evening before surgery to assess history, general conditions, airway and spine.

Statistical Analysis

Data was entered in an excel spread sheet and analysed using SPSS software package Parametric data has been presented as mean +/- SD. The categorical data has been analysed with Chi Square test. Quantitative data has been analysed using the unpaired student's t test / Mann Whitney test as appropriate. P < 0.05 has been considered as statistically significant.

RESULTS

Table 1: Level of onset of sensory block at zero minute in the study population

Drug combination		Frequency	Percentage
Group A - Hyperbaric Bupivacaine with Dexmedetomidine	L1	10	33.3
	L2	6	20.0
	T10	8	26.7
	T11	1	3.3
	T12	5	16.7
	Total	30	100.0
Group B - Hyperbaric Ropivacaine with Dexmedetomidine	L1	13	43.3
	L2	16	53.3
	T12	1	3.3
	Total	30	100.0

At zero minute of the study 26.7% of patients of bupivacaine group obtained T10 sensory level while NO patients of ropivacaine group attained T10 level at zero minute.

Table 2: Level of onset of sensory block at one minute in the study population

Drug combination		Frequency	Percentage
Group A - Hyperbaric Bupivacaine with Dexmedetomidine	L1	1	3.3
	L2	1	3.3
	T10	7	23.3
	T11	2	6.7
	T12	7	23.3
	T8	8	26.7
	T9	4	13.3
	Total	30	100.0
Group B - Hyperbaric Ropivacaine with Dexmedetomidine	T10	20	66.7
	T11	2	6.7
	T12	1	3.3
	T7	1	3.3
	T8	6	20.0
	Total	**30**	**100.0**

At 1 min. of study, 23.3% of patients of bupivacaine group has attained T10 level as compared to 66.7% in ropivacaine group.

Table 3: Level of onset of sensory block at five minutes in the study population

Drug combination		Frequency	Percentage
Group A - Hyperbaric Bupivacaine with Dexmedetomidine	T4	12	40.0
	T5	15	50.0
	T6	3	10.0
	Total	30	100.0
Group B - Hyperbaric Ropivacaine with Dexmedetomidine	T4	3	10.0
	T5	20	66.7
	T6	7	23.3
	Total	30	100.0

At 5 min, 40% patients of bupivacaine group reached T4 level while only 10% of patients of ropivacaine group reached T4 level which was significant.

Table 4: Onset of pain among

Second hour	Fourth hour	Sixth hour	Eighth hour			Tenth hour		
No pain			**Pain**	**Frequency (out of 30)**	**Percentage**	**Pain**	**Frequency (out of 30)**	**Percentage**
			Pain +	12	40.0	Pain +	18	60.0

Onset of first appearance of postoperative pain for bupivacaine group was noted around 10th hour for 60% patients and 8th hour for 40% patients.

Table 5: Onset of pain among

Second hour	Fourth hour	Sixth hour			Eighth hour			Tenth hour
No pain		Pain	Frequency (out of 30)	Percentage	Pain	Frequency (out of 30)	Percentage	Pain +
		pain+	11	36.7	pain +	19	63.3	

While in ropivacaine group 36.7% patients complained of pain at 6th hour, and 63.3% complained of pain at 8th hour. which was statistically significant.

Table 6: Comparison of mean HR between two study population at different point of time

HR at different point of time	Group A - Hyperbaric Bupivacaine with Dexmedetomidine			Group B -Hyperbaric Ropivacaine with Dexmedetomidine			Test – Mann Whitney U
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation	P Value
HR at zero minute	84.67	81.50	18.041	84.93	85.00	11.928	0.477
HR at two minutes	80.53	76.00	16.317	78.43	79.50	10.679	0.859
HR at five minutes	74.03	71.50	15.566	74.27	75.00	10.706	0.450
HR at fifteen minutes	71.13	70.00	15.269	70.20	70.00	10.643	0.923
HR at one hour	67.57	66.00	9.947	66.57	65.00	10.421	0.700
HR on completion of surgery	68.20	68.00	7.327	66.47	65.00	6.463	0.254

Non parametric test Mann Whitney U has done, there was no significant difference in mean HR between the two groups at different point of time.

Table 7: Comparison of mean MAP between two study population at different point of time

MAP at different point of time	Group A - Hyperbaric Bupivacaine with Dexmedetomidine			Group B - Hyperbaric Ropivacaine with Dexmedetomidine			Mann Whitney U - P Value
	Mean	Median	Std. Deviation	Mean	Median	Std. Deviation	
MAP at zero min	72.87	72.00	9.497	68.17	68.00	4.822	0.087
Two min MAP	67.30	66.00	8.691	66.03	64.00	5.968	0.467
Five min MAP	65.67	63.50	6.975	66.33	65.50	6.288	0.683
Fifteen min MAP	65.37	65.00	6.289	66.73	68.00	6.286	0.484
One hour MAP	66.03	64.50	5.822	68.87	68.00	6.095	0.069
MAP on completion	69.13	68.00	5.680	69.77	68.50	6.569	0.841

Non parametric test Mann Whitney U has done, there was no significant difference in mean MAP between the two groups at different point of time.

Table 8: Motor block level- Bromage scale (4-1) at different time point in the two group

Motor block level- Bromage scale (4-1)	Group A - Hyperbaric Bupivacaine with Dexmedetomidine			Group B -Hyperbaric Ropivacaine with Dexmedetomidine			Test – Mann Whitney U
	Median	Minimum	Maximum	Median	Minimum	Maximum	P Value
At zero min	3.00	2	4	4.00	3	4	**0.001**
At one min	2.50	2	3	3.00	3	4	**0.001**
At two min	2.00	1	3	3.00	2	3	**0.001**
At three min	2.00	1	3	2.00	2	3	**0.001**
At four min	1.00	1	2	2.00	1	2	**0.001**
At five min	1.00	1	2	1.00	1	1	0.317

Difference in Motor block level of two study populations were assessed using Bromage scale (4-1) at different point of times and it was found that there was a significant difference in motor block level (P Value <0.05) except at five minutes.

Table 9: Duration of Motor block level- Bromage scale (0 - 5) at different time point in the two group

Duration of Motor block Modified Bromage scale (0-5)	Group A - Hyperbaric Bupivacaine with Dexmedetomidine			Group B -Hyperbaric Ropivacaine with Dexmedetomidine			Test: Mann Whitney U
	Median	Minimum	Maximum	Median	Minimum	Maximum	P Value
One hour	1.00	1	1	1.00	1	1	1
Two hours	1.00	1	2	1.00	1	1	0.317
Three hours	1.50	1	2	2.00	2	3	**0.001**
Four hours	2.00	2	3	4.00	3	4	**0.001**

Difference in duration of Motor block level of two study populations were assessed using Modified Bromage scale (0-5) at different point of times and it was found that there was a significant difference in motor block level (P Value <0.05) except at first one hour and second hour motor block.

Table 10: Comparison of mean systolic BP between two study populations at different point of time

	Group A - Hyperbaric Bupivacaine with Dexmedetomidine Mean	Group B - Hyperbaric Ropivacaine with Dexmedetomidine Mean	Test – Mann Whitney U P Value
Systolic BP at zero min	124.27	125.70	0.739
Systolic BP at two min	111.13	117.73	0.477
Systolic BP at five min	107.10	114.20	0.059
Systolic BP at fifteen min	109.00	115.03	0.050
Systolic BP at one hour	115.57	117.43	0.830
Systolic BP at completion	120.30	159.03	0.446

On comparison of Mean systolic BP of two study populations at different time point there was no significant difference in the mean systolic BP at any time points.

Table 11: Comparison of mean diastolic BP between two study populations at different point of time

	Group A - Hyperbaric Bupivacaine with Dexmedetomidine Mean	Group B - Hyperbaric Ropivacaine with Dexmedetomidine Mean	Test – Mann Whitney U P Value
Diastolic BP at zero min	69.63	72.17	0.419
Diastolic BP at two min	64.47	67.73	0.171
Diastolic BP at five min	65.23	67.87	0.102
Diastolic BP at fifteen min	63.27	69.83	0.004
Diastolic BP at one hour	69.70	70.70	0.459
Diastolic BP at completion	71.20	72.50	0.366

On comparison of Mean diastolic BP of two study populations at different time point there was significant difference in BP at fifteen min and there were no significant differences at any other point of time.

DISCUSSION

Macnamee and Machelland,[9] investigated and compared equivoque (3.5 ml) plain ropivacaine 5mg/ml with bupivacaine 5mg/ml for spinal anaesthesia during major orthopaedic surgery and discovered that the onset of the sensory and the motor block was rapid, with no significant difference between the two groups. Whereas in the ropivacaine group, the average duration of motor block was significantly shorter. Surekha et al,[10] In a study comparing isobaric bupivacaine 0.5% and equivoque (2.2 ml) isobaric ropivacaine 0-75% for spinal anaesthesia during lower abdomen and lower limb procedures, it was discovered that bupivacaine produced superior sensory block quality and prolonged period of motor block than ropivacaine. In comparison to bupivacaine, they also discovered that the ropivacaine group experienced a shorter duration of sensory and motor blockage. The two groups' blood pressures did not differ much.

Karat et al,[11] tested 4 ml of 0.5% hyperbaric bupivacaine against 0.5% Hyperbaric ropivacaine was administered intrathecally for lower abdomen, perineal, and lower limb procedures, and the bupivacaine group had much earlier onset and peak sensory duration, with equivalent levels of cephalic spread in both groups. They also discovered that the ropivacaine group experienced less motor block and regressed faster than the bupivacaine group. There were no significant variations in haemodynamic parameters, with the exception of diastolic and mean pressures, which remained lower in the bupivacaine group.

Our study showed that hyperbaric bupivacaine when combined with dexmedetomidine gives faster onset of sensory and motor blockade. Bupivacaine group showed sensory level reaching T 10 level (20%) and motor block of bromage scale 2 (80%) within first 2 min of spinal anaesthesia as compared to sensory (6.7%) and motor block (30%) for patients in ropivacaine group. At 5 min, all subjects have attained sensory block T10 and a motor block of bromage scale 2. It has been noted that at the end of

4 hours of spinal anaesthesia, 83.3% patients with bupivacaine group showed bromage 2 scale motor block whereas motor block regressed to bromage scale 3 (36.7%) and scale 4 (63.3%) in ropivacaine group. At 4 hrs, 36% of Bupivacaine group maintained sensory level at T10 whereas, it was 10% in ropivacaine group. There was not much differences on heartrate over time in both groups. It was noted that even though not significant; there was fall in blood pressure and mean arterial pressure over time in both groups, changes more prominent in bupivacaine group. This indicates bupivacaine along with dexmedetomidine causes denser sympathetic blockade resulting in more hemodynamic changes compared to ropivacaine. We also found that onset of post operative pain was prolonged in both groups requiring a smaller number of analgesics. While first onset of postoperative pain was noted at 8^{th} hour (40%) and 10^{th} hour (18%) in bupivacaine group, it was early in ropivacaine group 36.7% at 6th hour and 63.3% in 8th hour. By 10^{th} hour all patients had complained of pain in ropivacaine group. These findings are similar to multiple studies which are stated earlier. Results of our study denotes that hyperbaric bupivacaine in combination with dexmedetomidine is superior to hyperbaric ropivacaine with dexmedetomidine in maintaining onset and duration of sensory and motor blockade with minimal hemodynamic fluctuations. It is also confirmed that hyperbaric bupivacaine with dexmedetomidine gives better postoperative analgesia and patient comfort compared to hyperbaric ropivacaine and dexmedetomidine group. This study did not have a placebo group to compare hyperbaric bupivacaine and dexmedetomidine. The study does not account for factors such as body build, obesity, and surgical duration, which may impact spinal blockade effectiveness.

CONCLUSION

Both hyperbaric bupivacaine and hyperbaric ropivacaine are potent local anaesthetics used for spinal anaesthesia. Moreover, addition of dexmedetomidine as an adjuvant helps to increase the density and duration of spinal block by potentiating the actions of local anaesthetics. Compared to ropivacaine with dexmedetomidine group, addition of dexmedetomidine to bupivacaine resulted in significantly decreased onset of time, prolonged duration of both the sensory and the motor blockade and better postoperative analgesia. These findings demonstrate that spinal ropivacaine is less effective than bupivacaine. The difference in the action may be due to increased lipid solubility of bupivacaine enabling it to penetrate large myelinated A fibres compared to less lipid soluble ropivacaine., It can be concluded that bupivacaine with dexmedetomidine is a better option meant for spinal anaesthesia for long duration lower limb orthopaedic and general surgical procedures.

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