

A comparative study of hemodynamic alterations with dexmedetomidine and nalbuphine as an adjuvant to ropivacaine in epidural anaesthesia

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Citation this Article: Dr. Sonali M. Khobragade, Dr. Aswin R. Krishnan, Dr. Jitendra P. Bhagat, “A comparative study of hemodynamic alterations with dexmedetomidine and nalbuphine as an adjuvant to ropivacaine in epidural anaesthesia”, IJMSIR - April - 2024, Vol – 9, Issue - 2, P. No. 20 – 32.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Epidural anaesthesia is very effective modality for peri-operative pain relief and anaesthesia. Epidural anaesthesia offers various advantages of regional anaesthesia along with hemodynamic stability. This study evaluates the hemodynamic effects of Nalbuphine and Dexmedetomidine as an adjuvant to Ropivacaine.

Material and methods: 70 adult patients with age in the range of 18-50 years, posted for lower limb surgeries under epidural anaesthesia were included in the study after approval from Institutional Ethics Committee.

Group RD (n=35): Patients received 15 ml of 0.75% Ropivacaine and Dexmedetomidine 1 mcg/kg epidurally (diluted with normal saline to make a total volume of 17 ml).

Group RN (n=35): Patients received 15 ml of 0.75% Ropivacaine and Nalbuphine 250 mcg/kg epidurally

(diluted with normal saline to make a total volume of 17 ml).

Results: The pulse rate was significantly lower in Dexmedetomidine group than Nalbuphine group at 20 min ($p<0.05$). The Systolic blood pressure, Diastolic Blood Pressure changes were comparable in Dexmedetomidine group and Nalbuphine group ($p>0.05$). There were significant changes in the Mean Arterial Pressure in Nalbuphine group in the study period at 15 min and 20 min ($p<0.05$).

Conclusion: We conclude that, Nalbuphine and Dexmedetomidine can be safely administered as an adjuvant to Ropivacaine in epidural anesthesia for lower limb surgeries as patients remained hemodynamically stable throughout the study period.

Keywords: Dexmedetomidine, Nalbuphine, Ropivacaine, Hemodynamics, Epidural Anaesthesia.

Introduction

Regional anaesthetic techniques are highly effective in pain management during various surgical procedures. Epidural anaesthesia allows the anaesthesiologist to place it at any level of the vertebrae to provide anaesthesia and analgesia, to supplement general anaesthesia, and therefore provides a haemodynamically stable operative course with less stress response. As early postoperative mobilization and rehabilitation without pain and discomfort are the most desirable features for modern orthopaedic and general surgeries, epidural becomes the preferred technique of anaesthesia¹. Epidural anaesthesia maintains intra-operative hemodynamic stability with less stress response causing reduced complications. Bupivacaine is being used epidurally since long but, it is a highly cardiotoxic local anaesthetic agent. Ropivacaine, a newer amide local anaesthetic, is a levorotatory propyl homologue of bupivacaine². Ropivacaine became a better alternative in the choice of local anaesthetic, due to its long duration of action and less cardiovascular effects³. The reversal of Na⁺ channel blockade is considerably faster with Ropivacaine when compared to Bupivacaine. Also, the negative inotropic potency of Ropivacaine on isolated cardiac tissue appears to be considerably less than that of Bupivacaine⁴. Opioids are most commonly used adjuvants. But, the side effects like nausea, vomiting, respiratory depression, pruritus, urinary retention limit their use as an adjuvant. Newer adjuvants like alpha-2 agonists⁵, steroids (dexamethasone)⁶, anti-inflammatory agents (parecoxib⁷ and lornoxicam⁸), midazolam⁹, ketamine¹⁰, magnesium sulphate¹¹ and neostigmine¹² are being considered with lesser side effects. α_2 adrenergic receptor agonists have been studied for their sedative, analgesic, perioperative sympatholytic and cardiovascular stabilizing effects with concomitant reduced anaesthetic requirements.

Dexmedetomidine is an alpha-2 agonist which has got numerous beneficial effects when used through epidural route¹³. It acts on both pre and postsynaptic sympathetic nerve terminals and central nervous system thereby decreasing the sympathetic outflow and nor-epinephrine release causing sedative, anti-anxiety, analgesic, sympatholytic and stable haemodynamic effects¹⁴⁻¹⁶. Nalbuphine is an opioid, partial agonist at both mu and kappa receptor. Its action on the kappa receptors attributes good sedative properties and partial agonism at the mu receptors induces a ceiling effect on respiratory depression. As with opioids, it is known to potentiate the action of local anaesthetics. Administered epidurally, it exerts its action by its interaction on opioid receptors present on the spinal cord^{17,18}. There is limited literature regarding hemodynamic changes following epidural administration of Nalbuphine and Dexmedetomidine along with Ropivacaine. Hence this study was planned for hemodynamic changes following epidural administration of Dexmedetomidine and Nalbuphine.

Material and Methods

The present prospective, comparative study was conducted in the Department of Anaesthesiology at a tertiary care centre to assess and compare hemodynamic changes with the use of epidural Nalbuphine and Dexmedetomidine as an adjuvant to Ropivacaine.

70 adult patients admitted in the Department of Orthopaedics, with age in the range of 18-50 years, posted for lower limb surgeries under epidural anaesthesia were included in the study after approval from Institutional Ethics Committee and a valid informed consent from patient.

Inclusion criteria's were patient belonging to ASA grade I or II, Age between 18 – 50 years, Height between 150-170 cm and Weight between 40-80 kg.

Exclusion criteria's were Patients who did not gave consent for regional anaesthesia, ASA grade III or IV, Patients with spine deformities, History of spine surgeries, seizure disorder and neurological disease, Patients with coagulation disorders and local infection, History of hypersensitivity to the local anaesthetic agent, History of cardiovascular diseases, Patients with COPD, liver and renal disorder.

Detailed pre-anaesthetic evaluation of the patients was performed by an anesthesiologist a day before the surgery. Preliminary investigations were done in the form of Complete blood count, HIV, HBsAg., Blood grouping and Rh typing, Random blood sugar level, LFT, KFT, Coagulation Profile, ECG, X-RAY chest. All the patients were given Tab. Pantoprazole 40 mg and Tab. Alprazolam 0.25 mg a night before the surgery.

In the operation theatre, a good peripheral intravenous access was secured using 18-gauge cannula and all patients were hydrated with 10 ml/kg of Ringer's lactate solution. Baseline pulse rate, non-invasive blood pressure, electrocardiogram and pulse oximetry were recorded after attaching a multipara monitor to the patient. The patients also received Inj. Pantoprazole 40 mg and Inj. Ondansetron 4 mg IV slowly as premedication.

Under all aseptic precautions, epidural catheterization was done. The patients were asked to sit for epidural catheterization and skin over the desired site was infiltrated with 2 ml of 2% Lignocaine. Epidural space of L2-L3/L3-L4 interspace was located using 18G Tuohy needle, midline approach and confirmed using the loss of resistance technique. An epidural catheter of 18-gauge was placed 3-5 cm in the epidural space. The epidural catheter was then fixed to the skin using a sterile adhesive dressing. The patient was then made supine. After exclusion of blood in the epidural catheter with

negative aspiration, 3 ml of 2% Lignocaine with adrenaline 1:2,00,000 test dose was administered to exclude intrathecal or intravascular placement of the catheter. After 5 minutes of administering the test dose, the patients received the study drug according to the study group allotted to them.

Group RD (n=35): Patients received 15 ml of 0.75% Ropivacaine and Dexmedetomidine 1 mcg/kg epidurally (diluted with normal saline to make a total volume of 17 ml).

Group RN (n=35): Patients received 15 ml of 0.75% Ropivacaine and Nalbuphine 250 mcg/kg epidurally (diluted with normal saline to make a total volume of 17 ml).

Intraoperatively, all patients were monitored for:

Heart rate, Blood pressure (systolic, diastolic and mean), Respiratory rate, SpO₂.

Heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and oxygen saturation were monitored continuously and recordings were made every 5 minutes until 30 minutes and at 10-minute interval thereafter up to 2 hours and finally at 30 minutes interval till the end of the surgery.

Intraoperatively and postoperatively, any incidence of bradycardia (heart rate < 60 beats per minute) was to be treated with 0.6 mg of injection Atropine and hypotension (systolic blood pressure falling more than 20% of baseline) with injection Mephentermine 3-6 mg in a bolus. Respiratory depression (SpO₂ < 95% or Respiratory rate < 8 breaths/min) if any, was to be treated by administration of 100% oxygen with face mask or ventilation with IPPV as per the need. During the peri-operative period, adverse effects like bradycardia, hypotension and fall in SPO₂ were monitored. Monitoring continued in the post-operative period every 6 hourly for 24 hours in recovery room.

Statistical Analysis

Data was collected, compiled, tabulated, coded and then statistically analysed using EPI info software version 7.2. Microsoft Word and Excel were used to generate graphs, tables etc.

- Numerical variables were presented as mean and standard deviation (SD).
- For numerical variables, Test applied – student unpaired t test.
- p value

Table 1

>0.05	Non-significant
<0.05	Significant
<0.001	Highly significant

Results

70 adult patients included in the study were compared with respect to age, weight, height and duration of surgery. The mean (\pm SD) age of patients in Group RD (Dexmedetomidine) was 31.49 (\pm 8.39) years and in Group RN (Nalbuphine) was 34.00 (\pm 7.78) years which was statistically not significant ($p=0.4838$) (NS). The mean (\pm SD) weight of patients in Group RD (Dexmedetomidine) was 66.86 (\pm 7.42) kg and in Group RN (Nalbuphine) was 67.80 (\pm 6.66) kg which was statistically not significant ($p=0.5779$) (NS). The mean (\pm SD) height of patients in Group RD (Dexmedetomidine) was 165.80 (\pm 3.27) cm and in Group RN (Nalbuphine) was 164.66 (\pm 2.48) cm which was statistically not significant ($p=0.1042$) (NS). In Group RD (Dexmedetomidine), 32 (91.43%) patients were males and 3 (8.57%) patients were females. In Group RN (Nalbuphine), 33 (94.29%) patients were males and 2 (5.71%) patients were females. Majority of the patients in both groups were males. The mean (\pm SD) duration of surgery in Group RD (Dexmedetomidine)

was 106.86 (\pm 20.40) minutes and in Group RN (Nalbuphine) was 109.71 (\pm 25.49) minutes. The difference in mean duration of surgery was statistically not significant ($p=0.6064$) (NS). The two groups were comparable with respect to age, height, weight and the duration of surgery.

Table 2: Mean (\pm SD) Pulse Rate Alterations In Group Rd:

Pulse rate	Group RD (n = 35)		P value
	Mean	SD	
Basal	85.91	4.88	Reference
After pre load	88.62	11.28	0.19
0 min	88.60	6.89	0.06
5 min	88.02	5.53	0.09
10 min	87.08	6.96	0.41
15 min	87.60	12.06	0.44
20 min	83.80	11.61	0.32
25 min	82.22	10.27	0.06
30 min	82.80	8.10	0.06
40 min	82.65	8.91	0.06
50 min	82.28	10.06	0.06
60 min	82.34	10.46	0.07
70 min	82.33	10.49	0.07
80 min	83.51	7.57	0.11
90 min	84.12	7.71	0.24
100 min	82.52	10.73	0.09
110 min	83.95	10.26	0.31
120 min	83.84	6.72	0.14
6 hours	84.20	5.03	0.15
12 hours	84.45	5.29	0.23
18 hours	83.57	5.58	0.06
24 hours	84.11	4.56	0.11

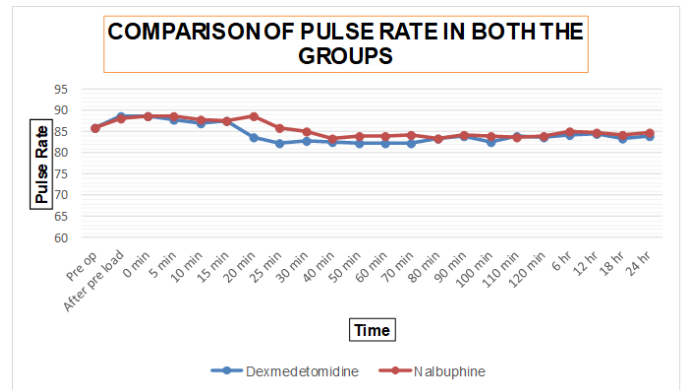
There was no significant change in the pulse rate in Dexmedetomidine group in the study period.

Table 3: Mean (±SD) Pulse Rate Alterations in Group RN

Pulse rate	Group RN (n = 35)		P value
	Mean	SD	
Basal	85.97	5.45	Reference
After pre load	88.08	5.87	0.12
0 min	88.68	8.38	0.11
5 min	88.62	9.04	0.14
10 min	87.80	8.22	0.27
15 min	87.68	6.47	0.23
20 min	88.85	9.43	0.12
25 min	86.08	9.02	0.95
30 min	85.17	8.77	0.64
40 min	83.51	8.43	0.15
50 min	84.05	6.81	0.19
60 min	84.08	6.71	0.20
70 min	84.25	5.47	0.19
80 min	83.54	5.52	0.06
90 min	84.34	4.74	0.18
100 min	84.07	7.30	0.22
110 min	83.63	4.61	0.06
120 min	84.10	3.25	0.08
6 hours	85.14	5.17	0.51
12 hours	84.77	5.31	0.35
18 hours	84.14	5.48	0.16
24 hours	84.74	5.18	0.33

There was no significant change in the pulse rate in Nalbuphine group in the study period.

Line diagram 1: comparison of mean pulse rate changes between the groups:



On intergroup comparison, the pulse rate was significantly lower in Dexmedetomidine group than Nalbuphine group at 20 min ($p < 0.05$). Heart rate was never below 60 beats per minute.

Table 4: Mean (±SD) Systolic Blood Pressure (SBP) Alterations In Group Rd:

Systolic blood pressure	Group RD		
	Mean	SD	P value
Basal	119.74	5.63	Reference
After pre load	120.31	5.17	0.66
0 min	119.91	4.85	0.89
5 min	118.28	3.80	0.20
10 min	117.85	3.44	0.09
15 min	117.68	3.79	0.07
20 min	117.54	5.98	0.11
25 min	117.51	4.71	0.07
30 min	117.91	5.25	0.16
40 min	117.51	3.98	0.05
50 min	117.54	3.72	0.06
60 min	117.60	3.30	0.06
70 min	117.84	3.11	0.08
80 min	117.78	2.85	0.07

90 min	118.30	2.87	0.18
100 min	118.34	4.35	0.24
110 min	118.85	4.00	0.44
120 min	119.61	5.77	0.92
6 hours	120.85	6.50	0.44
12 hours	121.17	5.52	0.28
18 hours	121.08	5.60	0.30
24 hours	121.34	6.31	0.26

There was no significant change in the Systolic Blood Pressure in Dexmedetomidine group in the study period.

Table 5: Mean (\pm SD) Systolic Blood Pressure (SBP)

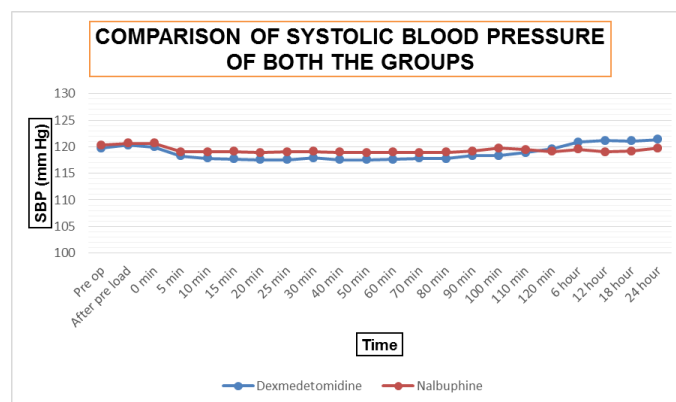
Alterations In Group RN:

Systolic blood pressure	Group RN		
	Mean	SD	P value
Basal	120.31	3.39	Reference
After pre load	120.62	3.37	0.70
0 min	120.62	3.53	0.70
5 min	119.05	2.95	0.10
10 min	119.02	2.17	0.06
15 min	119.08	2.00	0.06
20 min	118.88	2.90	0.06
25 min	119.02	2.15	0.06
30 min	119.08	2.97	0.11
40 min	118.97	2.66	0.07
50 min	118.85	2.86	0.06
60 min	118.97	2.59	0.06
70 min	118.85	2.89	0.06
80 min	118.94	2.57	0.06
90 min	119.14	1.77	0.07
100 min	119.70	2.40	0.38
110 min	119.42	3.01	0.24

120 min	119.10	7.94	0.40
6 hours	119.51	5.44	0.46
12 hours	119.02	5.53	0.24
18 hours	119.17	4.94	0.26
24 hours	119.74	5.08	0.58

There was no significant change in the Systolic Blood Pressure in Nalbuphine group in the study period.

Line diagram 2: comparison of mean (SD) systolic blood pressure changes between the groups



On intergroup comparison, the Systolic Blood Pressure was comparable in Dexmedetomidine group and Nalbuphine group ($p > 0.05$).

Table 6: Mean (\pm SD) Diastolic Blood Pressure (DBP)

Alterations In Group RD:

Diastolic blood pressure	Group RD		
	Mean	SD	P value
Basal	78.31	6.58	Reference
After pre load	80.22	5.65	0.19
0 min	80.71	5.56	0.10
5 min	78.51	7.37	0.90
10 min	76.02	7.49	0.17
15 min	75.71	5.44	0.07
20 min	76.20	6.46	0.18
25 min	76.17	5.32	0.13

30 min	77.05	5.07	0.37
40 min	77.11	4.66	0.38
50 min	77.22	5.85	0.46
60 min	77.37	5.24	0.51
70 min	77.12	6.86	0.46
80 min	77.21	5.72	0.45
90 min	77.48	7.45	0.62
100 min	78.13	6.37	0.90
110 min	77.40	6.58	0.56
120 min	77.85	5.92	0.75
6 hours	78.14	4.68	0.90
12 hours	78.34	4.99	0.98
18 hours	78.08	4.29	0.86
24 hours	78.02	4.65	0.83

There was no significant change in the Diastolic Blood Pressure in Dexmedetomidine group in the study period.

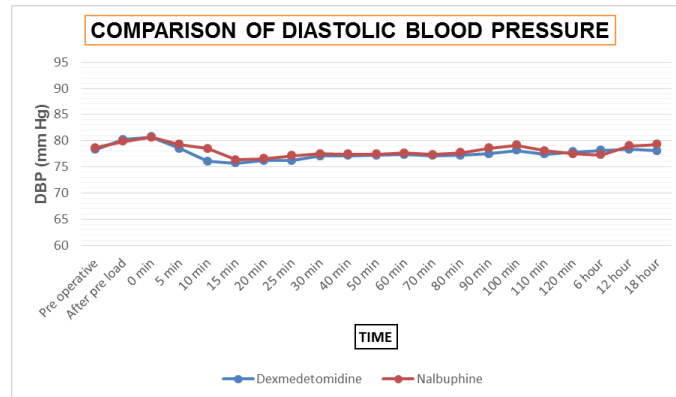
Table 7: Mean (\pm SD) Diastolic Blood Pressure (DBP) Alterations In Group RN:

Diastolic blood pressure	Group RN		
	Mean	SD	P value
Basal	78.65	4.79	Reference
After pre load	79.82	4.25	0.28
0 min	80.62	5.02	0.09
5 min	79.25	5.26	0.61
10 min	78.48	5.33	0.88
15 min	76.31	5.40	0.06
20 min	76.54	6.37	0.12
25 min	77.14	4.23	0.16
30 min	77.51	5.04	0.33
40 min	77.40	4.46	0.26

50 min	77.45	5.76	0.34
60 min	77.65	5.15	0.27
70 min	77.31	6.94	0.35
80 min	77.68	5.95	0.45
90 min	78.57	7.55	0.90
100 min	79.11	4.07	0.66
110 min	78.05	3.88	0.56
120 min	77.50	3.32	0.24
6 hours	77.28	5.06	0.20
12 hours	79.00	3.68	0.73
18 hours	79.31	5.02	0.57
24 hours	78.71	5.03	0.95

There was no significant change in the Diastolic Blood Pressure in Nalbuphine group in the study period.

Line Diagram 3: Comparison of Mean (SD) Diastolic Blood Pressure Changes between the Groups



On intergroup comparison, the Diastolic Blood Pressure changes were comparable in Dexmedetomidine group and Nalbuphine group ($p > 0.05$).

Table 8: Mean (\pm SD) Mean Arterial Pressure (Map) Alterations In Group RD:

Mean Arterial Pressure	Group RD		
	Mean	SD	P value
Basal	92.12	5.55	Reference

After pre load	93.40	5.00	0.31
0 min	93.78	4.55	0.17
5 min	91.77	5.53	0.79
10 min	89.97	5.37	0.10
15 min	89.95	3.98	0.06
20 min	89.98	5.23	0.10
25 min	89.95	3.95	0.06
30 min	90.67	3.93	0.20
40 min	90.58	3.29	0.16
50 min	90.66	3.76	0.20
60 min	90.78	3.62	0.23
70 min	90.69	4.85	0.25
80 min	90.73	4.05	0.23
90 min	91.75	5.12	0.77
100 min	91.53	4.97	0.64
110 min	91.21	4.79	0.46
120 min	91.66	4.85	0.71
6 hours	92.38	4.24	0.82
12 hours	92.61	4.03	0.67
18 hours	92.41	3.69	0.79
24 hours	92.46	3.76	0.76

There was no significant change in the Mean Arterial Pressure in Dexmedetomidine group in the study period.

Table 9: Mean (±SD) Mean Arterial Pressure (Map)

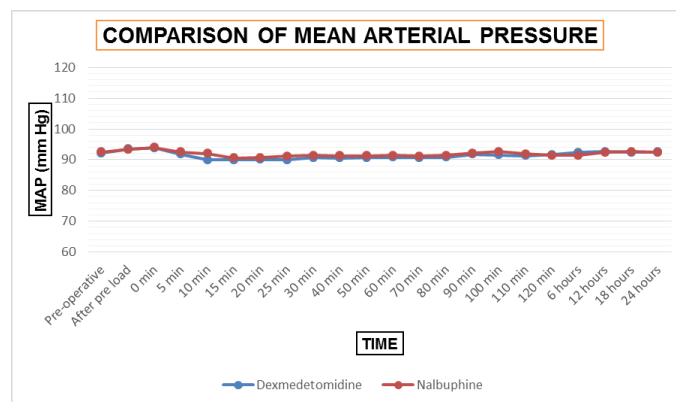
Alterations in Group RN:

Mean Arterial Pressure	Group RN		
	Mean	SD	P value
Basal	92.54	3.53	Reference
After pre load	93.32	3.33	0.34
0 min	93.96	3.38	0.09
5 min	92.52	3.52	0.98
10 min	92.00	3.62	0.52
15 min	90.57	3.69	0.02(S)

20 min	90.65	4.20	0.04(S)
25 min	91.10	2.83	0.06
30 min	91.37	3.62	0.17
40 min	91.25	3.07	0.10
50 min	91.25	3.75	0.14
60 min	91.42	3.43	0.18
70 min	91.16	4.85	0.17
80 min	91.43	4.21	0.23
90 min	92.09	5.25	0.67
100 min	92.64	2.97	0.89
110 min	91.84	3.03	0.37
120 min	91.36	2.80	0.12
6 hours	91.36	4.26	0.21
12 hours	92.34	3.37	0.80
18 hours	92.60	3.89	0.94
24 hours	92.39	4.02	0.86

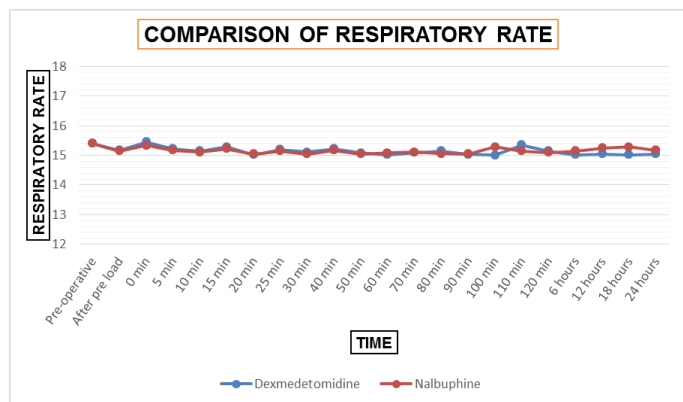
There was no significant change in the Mean Arterial Pressure in Nalbuphine group in the study period except at 15 min and 20 min ($p < 0.05$).

Line Diagram 4: Comparison of Mean (SD) Mean Arterial Blood Pressure Changes Between The Groups



On intergroup comparison, the Mean Arterial Pressure was comparable in Dexmedetomidine group and Nalbuphine group ($p > 0.05$).

Line Diagram 5: Comparison of Mean (SD) Respiratory Rate Changes between the Groups



There was no significant change in the Respiratory Rate in Nalbuphine group and Dexmedetomidine group in the study period ($p > 0.05$).

Table 10: Perioperative Complications:

Side effects	Group RD (n=35)	Group RN (n=35)
Hypotension	0	0
Bradycardia	0	0

The hypotension and bradycardia were not observed in any patients of either group.

Discussion

Regional anaesthesia reduces incidence of pulmonary embolism, deep vein thrombosis and reduced bleeding and transfusion requirement. Epidural anaesthesia is commonly used for providing intraoperative surgical anaesthesia and postoperative analgesia in lower abdominal and lower limb surgeries¹⁹. Ropivacaine, a newer amide local anesthetic, is a levorotatory propyl homologue of Bupivacaine. It is less toxic to the nervous system and heart and has a lesser propensity of motor block as compared to Bupivacaine², because of its structural and physiochemical properties. Hence early ambulation of the patients can be done thereby decreasing morbidity in the postoperative period.

Dexmedetomidine is an α_2 agonist which has got numerous beneficial effects when used through epidural

route²⁰. It acts on both pre and postsynaptic sympathetic nerve terminal and central nervous system thereby decreasing the sympathetic outflow and nor-epinephrine release causing sedative, anti-anxiety, analgesic, sympatholytic and haemodynamic effects¹⁴⁻¹⁶. The striking feature of this drug is the lack of opioid-related side effects like respiratory depression, nausea and vomiting^{21,22}.

Nalbuphine is an opioid, partial agonist at both mu and kappa receptor. Its action on the kappa receptors attributes good sedative properties and partial agonism at the mu receptors induces a ceiling effect on respiratory depression. As with opioids, it is also known to potentiate the action of local anaesthetics. Administered epidurally, it exerts its action by its interaction on opioid receptor present on the spinal cord^{17,18}. Epidural anaesthesia is considered to be hemodynamic stable form of anaesthesia. Hence, hemodynamic alterations caused by epidural administration of Dexmedetomidine and Nalbuphine must be studied.

The two groups were comparable with respect to age, weight, height and duration of surgery.

Hemodynamic parameters

Pulse Rate

There was no significant change in the mean (\pm SD) Pulse Rate of Group RD after administration of Dexmedetomidine and Nalbuphine at various time intervals in the present study. On intergroup comparison, there was no statistically significant difference in mean (\pm SD) Pulse Rate between the two groups at various time intervals till 24 hours except at 20 minutes where the Pulse rate was less in Group RD (Dexmedetomidine) than in Group RN (Nalbuphine) ($p < 0.04$). It was not less than 60 beats per minute.

Bajwa SJS, Bajwa SK, Kaur J et al (2011)²⁰ observed that the heart rate remained stable in both the groups

throughout the study period. A slight decrease in heart rate was observed in Dexmedetomidine and Clonidine group but it never fell down to more than 15% of baseline values.

Arunkumar S, Kumar VRH et al (2015)²³ observed a significant fall in heart rate by 20% in 30 - 50 minutes after the epidural injection in Dexmedetomidine and Clonidine group. On intergroup comparison, the mean heart rate changes were comparable in both the groups.

Munnoli TB, Singh G et al (2016)²⁴ observed that the mean heart rate was comparable between the Clonidine group and Dexmedetomidine group during intraoperative and postoperative period.

Michael RM, Mehta M (2016)²⁵ observed no significant changes in mean pulse rate between Dexmedetomidine and Nalbuphine group at various time intervals.

Sarkar S, Chattopadhyay S et al (2017)²⁶ observed that the heart rate was significantly lower in Ropivacaine with Dexmedetomidine group than Ropivacaine group at 15 min, 105 min and 120 min ($p < 0.05$).

Chetty DK, Ahmed F et al (2018)²⁷ observed that intra-operatively heart rate was comparable among plain Bupivacaine, Nalbuphine and Clonidine group without requiring any treatment.

Hence, the results of our study were in accordance with the studies mentioned above.

SBP, DBP and MAP

There was no significant change in the Systolic blood pressure, Diastolic blood pressure and the Mean arterial blood pressure of Group RD (Dexmedetomidine) at various time intervals in the present study ($p > 0.05$). In our study, it was observed that there was fall in MAP at 15 minutes and 20 minutes in Group RN (Nalbuphine), then it stabilized to basal values. The fall in mean arterial blood pressure was never less than 90 mmHg in the study period.

In the present study, on intergroup comparison the mean (\pm SD) systolic blood pressure, diastolic blood pressure and Mean arterial blood pressure were comparable between both the groups at various time intervals ($p > 0.05$) (NS). None of the patient required Inj. Mephentermine for the treatment in any of the group. Hence, all the patients were hemodynamically stable throughout the study period in Dexmedetomidine group and Nalbuphine group. Thus, Hypotension was not noted in any patients of either group. All patients were hemodynamically stable throughout the study period in Dexmedetomidine and Nalbuphine group.

Bajwa SJS, Bajwa SK, Kaur J et al (2011)²⁰ observed that the hemodynamics in Dexmedetomidine group and Clonidine group remained stable throughout the study period. A slight decrease in mean arterial pressure which was less than 15% of the baseline values was observed in Dexmedetomidine group and Clonidine group.

Arunkumar S, Kumar VRH et al (2015)²³ observed a significant fall in mean arterial pressure by 25% in 40-50 minutes after the epidural injection in Clonidine and Dexmedetomidine group. However, this change was statistically insignificant ($p > 0.05$) (NS).

Munnoli TB, Singh G et al (2016)²⁴ observed that the mean systolic, diastolic and mean arterial pressure were comparable during intraoperative and postoperative period in Ropivacaine group, Clonidine group and Dexmedetomidine group ($p > 0.05$) (NS).

Arora V, Khan MZ et al (2016)²⁸ observed no statistical difference in SBP and DBP in Dexmedetomidine and Neostigmine group ($p > 0.05$) (NS).

Michael R, Mehta M (2016)²⁵ observed no significant changes in mean SBP and DBP between Dexmedetomidine and Nalbuphine group at any time intervals ($p > 0.05$) (NS).

Prabhakaraiah UN et al (2017)²⁹ observed that the systolic blood pressure and mean arterial pressure were comparable between Fentanyl and Nalbuphine group ($p>0.05$) (NS).

Sarkar S, Chattopadhyay S et al (2017)²⁶ observed that the mean arterial pressure between plain Ropivacaine and Dexmedetomidine group was comparable at different time intervals ($p>0.05$) (NS).

Chetty DK, Ahmed F et al (2018)²⁷ observed that intraoperatively SBP, DBP and MAP were comparable among plain Bupivacaine, Nalbuphine and Clonidine group ($p>0.05$) (NS).

Hence, the results of our study regarding hemodynamics were in accordance with the studies mentioned above.

Respiratory Rate

In our study, there were no significant changes in Respiratory Rate of Group RD (Dexmedetomidine) and Group RN (Nalbuphine) at various time intervals. No respiratory depression was observed in any patient of either group. SpO₂ was maintained within normal limits in all the patients of Dexmedetomidine and Nalbuphine group.

Khobragade S, Kalbhor J et al (2017)³⁰ observed that none of the patients in Dexmedetomidine and Nalbuphine group developed respiratory depression.

Chetty DK, Ahmed F et al (2018)²⁷ observed that none of the patients in plain Bupivacaine, Nalbuphine and Clonidine group developed respiratory depression.

Hence, the results of our study regarding the respiratory rate were similar to the above mentioned studies.

Complications

In our study, none of the patients, in either group, had bradycardia, hypotension and respiratory depression..

In the study by **Chetty DK, Ahmed F et al (2018)²⁷**, bradycardia was seen in 2 patients of Bupivacaine group, 3 patients of Clonidine group and none in Nalbuphine

group ($p=0.227$) (NS). 6 patients of Bupivacaine group, 6 patients of Clonidine group and 4 patients of Nalbuphine group developed hypotension ($p=0.738$). Nausea and vomiting were seen in 4 patients of Bupivacaine group, 3 patients of Clonidine group and 3 patients of Nalbuphine group ($p=0.894$). 1 patient in Nalbuphine group had itching whereas no patient in Clonidine and Ropivacaine group had itching.

In the study by **Das RK, Pradhan A et al (2017)³¹**, the incidence of dry mouth was higher in Dexmedetomidine group than Ketamine group. The incidence of shivering and nausea were comparable in both the groups.

In the study by **Khobragade S, Kalbhor J et al (2017)³⁰**, nausea was seen in 3 patients of Nalbuphine group. Vomiting was seen in 1 patient of Nalbuphine group. None of the patient in Dexmedetomidine developed nausea and vomiting. Dry mouth was seen in 1 patient of Dexmedetomidine group and none in Nalbuphine group.

In our study the side effects were minimal and managed accordingly.

Conclusion

We conclude that, Nalbuphine and Dexmedetomidine can be safely administered as an adjuvant to Ropivacaine in epidural anesthesia for lower limb surgeries as patients remained hemodynamically stable throughout the study period.

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