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Original Research Article

An Observational Study of Ropivacaine 0.2%, Ropivacaine 0.5% and Bupivacaine 0.25% in Post-Operative Epidural Analgesia

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Abstract

Objective: The present study aimed to evaluate the quality of postoperative analgesia, hemodynamic profile, sensory block achieved with Ropivacaine (0.20% and 0.50%) and Bupivacaine (0.25%) used for epidural analgesia in lower limb orthopaedic surgery.

Methods: In this observational prospective study the participants included a representative sample of patients admitted to the department of orthopaedics for lower limb surgeries. Study participants were allotted to the study groups sequentially. The first 30 recruited participants were allotted group I, the next 30 participants recruited was allotted group II and the last 30 participants were allotted the group III. An epidural catheter (19 G) advanced cephalad 3–5 cm into the epidural space. Quality of postoperative analgesia, hemodynamic profile, sensory block was evaluated and findings recorded.

Results: The duration of postoperative analgesia and onset of pain relief was longest in group II (Ropivacaine 0.5%), followed by the group I (Ropivacaine 0.2%) and was shortest in group III (Bupivacaine 0.2%). The mean time of onset of sensory blockade was quickest in group II (14.2%), followed by the group I, and was most delayed in group III (28.7 minutes). The total duration of sensory block was longest in group II (310.56), followed by group I and was shortest in group III (191.2 minutes) respectively. The difference in change in the blood pressure was not statistically significant between the group I (0.2% Ropivacaine) and group III (0.25% Bupivacaine). The difference in change in the blood pressure was not statistically significant between the group I (0.2% Ropivacaine) and group II (0.5% Ropivacaine). None of the subjects included in the study had any side effects like bradycardia or hypotension.

Conclusion: The study subjects in group II showed the characteristics which are most desired by both an orthopaedic surgeon and anaesthetist during and immediately after the surgery. Thus, among the three-drug formulations compared in this study, the author believes that Ropivacaine given in concentration of 0.5% was most aptly suited for postoperative epidural analgesia in lower limb orthopaedic surgeries.

Keywords: Ropivacaine, Bupivacaine, Quality of postoperative analgesia, hemodynamic profile, sensory block

Introduction

The postoperative period is characterized by an increment in the plasma levels of catabolic hormones and a reduction in the plasma levels of anabolic hormones leading to increase plasma glucose, sodium retention, fatty acids, and lactate levels. [1-3] Subsequent hyperglycemia leads to poor wound healing and immunosuppression leading to increased risk of nosocomial infections [6]. Inadequate pain relief also causes inhibition of spinal reflex mediated by the phrenic nerve, thereby decreasing pulmonary ventilatory capacity leading to pulmonary complications. Nausea and vomiting are also noticed during the postoperative period due to stimulation of nociceptive receptors located in the viscera and somatic structures. Hypomotility of gastrointestinal tract and bladder leads to paralytic ileus and urine retention. The postoperative immobility is also an independent risk factor for developing deep vein thrombosis. Apart from providing adequate pain relief, epidural local anaesthetics promote convalescence by blunting autonomic and somatic reflexes to pain. [4,5]

After the widespread use of bupivacaine, several researchers recognized the life-threatening cardiotoxicity related to its use. This fatal complication associated with bupivacaine motivated researcher to develop an anaesthetic agent comparable with bupivacaine but with lower cardiotoxicity. Their search ended with the development of ropivacaine, which became widely available for use in 1996, however it was permitted to be used in India only in 2009. Based on this profile, it is beneficial in situations where the motor block is undesirable. [6] In equal concentrations, ropivacaine and bupivacaine produced similar sensory and motor block after epidural administration with slightly longer block duration with bupivacaine. Increasing the concentrations of ropivacaine resulted in quicker onset, greater intensity, slower regression, and longer duration of the motor blockade. Some studies revealed similar sensory blockade characteristics of ropivacaine and bupivacaine while some revealed the lesser duration of analgesia with ropivacaine at equal concentrations. Crosby et al. "showed that 0.5% ropivacaine and 0.5% bupivacaine produced equally effective sensory block for cesarean section with the median duration of sensory block varied between 1.7–4.2 h for ropivacaine and 1.8–4.4 h for bupivacaine". [7]

Another study by Wolff et al. "compared epidural ropivacaine (0.5%, 0.75%, and 1%) and 0.5% bupivacaine in patients undergoing hip surgeries and showed that 0.5% ropivacaine and 0.5% bupivacaine were indistinguishable concerning sensory and motor block characteristics while 1% ropivacaine produced a longer duration of analgesia and more intense motor block than 0.5% bupivacaine".Brown et al. compared 0.5% ropivacaine and 0.5% bupivacaine for epidural anaesthesia in 45 patients undergoing lower extremity surgery and showed that bupivacaine produced slightly longer duration of a motor blockade than ropivacaine but did not find any statistically significant difference in the onset of analgesia or highest sensory level achieved. Casati et al. "evaluated the onset time, duration of epidural anaesthesia, and the quality of postoperative analgesia produced by 0.5% levobupivacaine, 0.5% bupivacaine, and 0.5% ropivacaine in 45 patients undergoing total hip replacement surgery in a randomized controlled manner and found the degree of pain relief to be similar in three groups without the difference in local anaesthetic consumption". [8,9]

Materials and Methods

The present study was conducted at LN Medical College, Bhopal. The data collection for the present study was started after obtaining ethical clearance from the

Institute's Ethical Committee on Human Research .

Study Design: This was an observational prospective study.

Study Setting: The present study was conducted at the Department of Anesthesiology, LN Medical College Bhopal. It is a tertiary care institute which caters to the need of about 500,000 population. Each year about 800 major and minor surgeries are conducted at the institute.

Study Duration: The total duration of the study was 16 months; from April 2019 to July 2020.

Study Participants: The participants included a representative sample of patients admitted to the department of orthopaedics for lower limb surgeries. All the patients admitted to the department of orthopaedics to be operated upon the lower limb for any type of ailments were screened using the selection criteria until the required sample size was met.

Inclusion Criteria:

a. Patients with ASA Grading I and II
b. Patients between 18-80 years of age.

Exclusion Criteria:

a) Patients with ASA Grading III, IV and V.
b) Patients below 18 years and above 80 years of age.
c) Pregnant patients.
d) Patient with a cardiovascular abnormality.
e) Patient refusal to give written consent for the study.
f) Local infection at lumbar area preventing the administration of epidural anaesthesia.
g) Pre-existing neurological disorders.

Sample Size: A total of 90 participants were included in the present study. These 90 patients were divided into 3 study groups of 30 participants each. The details of the sample size calculation are given.

Study Group: All study participants were divided into three study groups. Study participants were allotted to the study groups sequentially. The first 30 recruited participants were allotted group I, the next 30 participants recruited was allotted group II and the last 30 participants were allotted the group III.

Epidural Anesthesia: Under strict aseptic precautions, Lumbar epidural anaesthesia was performed using 17G Touhy needle with patients in the sitting position in L3-L4 interspace and location of epidural space was confirmed by loss of resistance technique. An epidural catheter (19 G) advanced cephalad 3–5 cm into the epidural space. A test dose of 3 ml of 2 % lignocaine with adrenaline was administered into epidural space and thereafter epidural catheter was secured and patients were placed supine.

Data Collection: The data was collected on the following variables:

Age: Self-reported by patients.

Gender: Self-reported by patients

Type of surgery: The details of the surgical procedure like the type of surgery, duration of surgery, pre-existing condition, anatomical site(s) etc. were obtained from the patient's case records. Any discrepancies were resolved by verifying from OT records.

Preoperative evaluation: Past medical and surgical history, drug intake history, clinical evaluation, airway assessment, and routine investigations. This information was collected using the patient's case records.

Additional analgesic medications: Detail of all the medication given during the pre-, intra-, and postoperative period including the timing, dose, and frequency of all medications given to the study participants were obtained from patient's case records. Any discrepancies in the medications given

were resolved after verifying from nursing records.

Time of first rescue analgesia: Time interval from the complete onset of anaesthesia to the time the patient experienced pain exceeding a verbal analogue score of four (VAS> 4).

Visual Analogue Scale (VAS) score: Visual Analogue Scale (VAS) was explained in detail to the patients in the preoperative period [59].

Total doses of LA given: Total number of epidural doses of anaesthesia given during the postoperative period after the onset of pain. This information was collected from the patient's case record.

Time of onset of pain in the post-operative period: Time interval from the completion of anaesthesia to the time when the patient complains of pain. Postoperative pain was assessed by visual analogue scale (VAS) at 2 h, 4 h, 6 h, 8 h, 10 h, 12 h, 18 h, and 24 h after surgery.

The onset of pain relief: Time interval between the end of the administration of the drug and the onset of sensory block at T10 level was evaluated using midline loss of cold sensation every minute till complete sensory block at T10.

Sensory block:

a. **The onset of the sensory block** - Time from an injection of the local anaesthetic in epidural space up to the time when the patient does not feel the pinprick at T12 level .
b. **Duration of the sensory block** - The interval from epidural administration to the point of two-segment regression of sensory blockade.
c. **Assessment of sensory block:** Sensory block was assessed by loss of sensation to pinprick in the midline using a 22-gauge blunt hypodermic needle every 5 min until no change in level occurred 5 min apart.

Motor block: Degree of motor block was assessed after a complete sensory block was achieved at the T10 level using a modified Bromage scale every 5 minutes.

a. 0 = No block
b. 1 = Inability to raise the extended leg
c. 2 = inability to flex the knee
d. 3 = inability to flex ankle and foot

Side effects and Complications: During surgical procedure side effects like nausea, vomiting, anxiety, dry mouth, dizziness, headache, pruritis, shivering and respiratory depression were recorded.

Observation Chart

Table 1: Distribution of study participants by Gender and Age (n=90)

Distribution of study participants by Gender and Age (n=90)				
Age group	**Male**		**Female**	
	n	**%**	**n**	**%**
<=30	18	78.26	5	21.74
31-40	12	75.00	4	25.0
41-50	7	58.33	5	41.67
51-60	10	62.5	6	37.5
>60	13	56.52	10	43.48
Mean Age	**45.25**		**51.4**	

Table 2: Distribution of study participants based on time of onset of pain in the postoperative period(n=90)

Distribution of Study Participants based on Time of onset of Pain in the Postoperative period(n=90)								
The onset of Pain (in hours)	Group 1		Group 2		Group 3		Total	
	n	%	n	%	n	%	n	%
Between 2-3	2	12.5	2	12.5	12	75.0	**16**	**17.8**
Between 3-4	14	32.6	16	37.2	13	30.2	**43**	**47.8**
Between 4-5	13	43.3	12	40.0	5	16.7	**30**	**33.3**
5 hours or later	1	100.0	0	-	0		**1**	**1.11**
Mean	253.30 minutes		287. 57 minutes		215.70 minutes		-	

Table 3: Distribution of study participants based on Visual Analogue Scale score (n=90)

Distribution of study participants based on Visual Analogue Scale score (n=90)								
VAS Score	Group 1		Group 2		Group 3		Total	
	n	%	n	%	n	%	n	%
6	8	18.6	16	37.2	19	44.2	**43**	**47.8**
7	1	100.0	0	-	0	-	**1**	**1.1**
8	21	45.7	14	30.4	11	23.9	**46**	**51.1**

Table 4: Distribution of study participants based on Time for Pain relief (n=90)

Onset of Pain relief (minutes)	Group 1		Group 2		Group 3		Total	
	n	%	n	%	n	%	n	%
<=15	5	15.6	27	84.4	0	-	**32**	**35.6**
16-30	25	59.5	3	7.1	14	33.3	**42**	**46.7**
31-45	0	-	0	-	16	100.0	**16**	**17.8**
Mean	22.6		12.9		35.3		23.65	

Table 5: Distribution of study participants based on time of onset and duration of sensory block (n=90)

Table 5: Distribution of study participants based on time of onset and duration of sensory block (n=90)			
Time* for the onset of sensory block	Group 1	Group 2	Group 3
The onset of Sensory Block			
Mean	21.5	14.2	28.7
Duration of Sensory Block			
Mean	245.5	310.56	191.2
*- Duration in minutes			

Results

1. The duration of postoperative analgesia was longest in group II (Ropivacaine 0.5%), followed by the group I (Ropivacaine 0.2%) and was shortest in group III (Bupivacaine 0.2%).
2. The onset of pain relief was quickest in group II (Ropivacaine 0.5%), followed by the group I (Ropivacaine 0.2%) and was most delayed in group III (Bupivacaine 0.2%).
3. Overall, more than one third (35.6%) of all study participants did not require any additional analgesic medication. Most of these participants (about 85%) belonged to group II.
4. The mean time of onset of sensory blockade was quickest in group II

(14.2%), followed by the group I, and was most delayed in group III (28.7 minutes).
5. The total duration of sensory block was longest in group II (310.56), followed by group I and was shortest in group III (191.2 minutes) respectively.
6. None of the subjects included in the study had any side effects like bradycardia or hypotension.

Statistical Analysis:

All the data was collected in a paper-based data collection form. Thereafter, the data were coded and entered in Microsoft Excel. The coded data were imported into Stata 15.1 version for analysis. For the continuous data, we calculated the mean, median, and standard deviation. For discrete data, we calculated and reported frequency, proportion, and percentage. Any statistical difference between the two proportions was estimated using the Chi-square test. Any statistical difference between the two means was estimated using the T-test.

Discussion

The present study entitled "A Prospective observational study of Ropivacaine 0.2%, Ropivacaine 0.5%, and Bupivacaine 0.25% for Post-operative Epidural analgesia in Orthopaedics Surgeries of Lower Limb" was undertaken at LN Medical College, Bhopal to compare and evaluate the analgesic efficacy, hemodynamic response (during the postoperative period), the sensory blocking profile of Ropivacaine (0.20% and 0.50%) and Bupivacaine (0.25%) used as epidural analgesia for lower limb orthopaedic surgeries. After getting ethical approval from the Institutional Ethical Committee a total of 90 patients posted for various lower limb surgeries were enrolled in the present study. [10-14]

Post-operative period is marked by several physiological changes which affect the quality of life or in some cases may hamper or delay recovery of patients thereby increasing the overall cost of hospital stay. The author, therefore, conducted the present study to observe and report the findings of the two most common local anesthetic used for epidural anesthesia. Further, the findings of the present study will also provide evidence about the effectiveness of two different concentrations of more commonly used LA Ropivacaine used in clinical practice. [15]

In the present study, most patients (about 26.0%) belonged to the two extreme age groups viz. under 30 years and over 60 years of age. Overall, only 13.3 percent of total participants belonged to 41-50 years of age. The mean age of participants in group I, II and III was 55.2 years, 29.8 years, and 56.86 years, respectively. Overall, two-thirds of study participants were male and rest one-third were female. Male aged less than 30 years formed the largest demographic group among the study participants whereas women aged between 31-40 years formed the smallest demographic group. Further, the mean age of female participants was greater (51.4 years) in comparison to the mean age (45.25 years) of male participants. Like our findings, males were more common among both study group. [16]

The Onset of Postoperative Pain: We noted that most (47.8%) patients started feeling pain (greater than VAS 4) sometime between three and four hours after the completion of surgery and only 17.8 % of patients reported onset of pain between two and three hours after surgery. In the present study, the mean duration of analgesia in the group I, group II and group III were 252 minutes, 283 minutes, and 248 minutes, respectively. There was no statistically significant difference between group I and group III regarding the duration of postoperative analgesia. In other words, the duration of analgesia was comparable between ropivacaine and bupivacaine when used in almost similar concentration. [17,18]

Similar to our findings Brockway et al. also reported that the duration of epidural analgesia was comparable between Ropivacaine and Bupivacaine when used at equal concentration and dosage . Mehta S et al. reported that the mean duration of action of epidural analgesia in Group B (bupivacaine 0.2%) was 253 minutes and 251 minutes in Group R (ropivacaine 0.2%). They do not observe any statistically significant difference between the two study groups. Similarly, Bindra TK et al. also reported no statistically significant difference in the duration of analgesia between 0.5% bupivacaine and 0.5% ropivacaine group. However, Brown et al. reported that 0.5% bupivacaine provided long-lasting sensory analgesia in comparison to 0.5% ropivacaine [19]. Like our findings, Zaric et al., compared three concentrations of ropivacaine (0.5%, 0.75%, and 1%) and noted that duration of postoperative analgesia increased with an increase in drug concentration. Sandler et al., also noted that the duration of analgesia was higher for 1.0% ropivacaine in comparison to 0.5% ropivacaine. [20]

Onset of Pain Relief: In the present study, the onset of pain relief in most patients (46.7%), was between 16-30 minutes after the injection, followed by less than 15 minutes among 35.6% of patient. Among the three study groups, the mean duration of onset of analgesia was quickest for group II (Ropivacaine 0.5% - mean duration for onset 12.9 minutes), followed by the group I (Ropivacaine 0.2%- mean duration of onset 22.6 minutes), the onset of action was most delayed among group III patients. Mehta S et al. noted that the mean onset time of analgesia in Group B (0.2% bupivacaine) was 10.46 min and 10.52 min in Group R (0.2% ropivacaine), which was statistically insignificant (P = 0.665). The longer duration of onset in our study could be explained lower volume and thus total drug infused into participants in our study. However, in contrast to our findings, Brockway et al. did not observe any significant difference in the onset of pain relief between the equal concentration (0.5% each) of Bupivacaine and Ropivacaine. Like Brockway's findings, the McCrae et al. did not observe any difference in the onset of pain relief between Bupivacaine and Ropivacaine given in equal doses. [21]

Onset and Duration of Sensory Block Level:

In the present study, the meantime of onset of sensory blockade in group I, II and group III was 21.5, 14.2, and 28.7 minutes. In the present study, the difference in the onset of sensory block was statistically significant between the groups I and II (p=0.014). The author noted that the mean duration of sensory block in group I, II and group III was 245.5, 310.56, and 191.2 minutes, respectively. The difference was statistically significant between the group I and II (p=0.015) and group II and group III (p=0.008)

Korula et al. compared "the clinical efficacy of the equipotent doses of ropivacaine 0.75% and bupivacaine 0.25% for epidural anaesthesia and found no significant variation in the sensory block profile". Bindra TK et al. noted the onset of sensory block was quicker among patients administrated receiving 0.75% ropivacaine as compared to either 0.5% ropivacaine and 0.5% bupivacaine, and this difference was statistically significant. They also reported that the total duration of sensory blockade was significantly longer with 0.75% ropivacaine than 0.5% ropivacaine and 0.5% bupivacaine. Finucane et al. comparing three doses of ropivacaine (0.5%, 0.75%, and 1%) with 0.5% bupivacaine in patients undergoing hysterectomy also reported similar findings . [22]

Conclusion

In conclusion, the study subjects in group II showed the characteristics which are most desired by both an orthopaedic surgeon and anaesthetist during and immediately after

the surgery. Thus, among the three-drug formulations compared in this study, the author believes that Ropivacaine given in concentration of 0.5% was most aptly suited for postoperative epidural analgesia in lower limb orthopaedic surgeries.

Declarations:

Funding: None **Availability of data and material**: Department of Anaesthesiology LNMC & JK Hospital **Code availability**: Not applicable **Consent to participate**: Consent taken **Ethical Consideration**: There are no ethical conflicts related to this study. **Consent for publication**: Consent taken

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