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Original Research Article

A Comparative Study Between Dexmedetomidine and Fentanyl as Adjuvant with Bupivacaine in Epidural Anesthesia in a Patient Undergoing Total Hip Replacement

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Conflict of interest: Nil

Abstract:

Background: After total hip replacement, analgesic demand is very significant due to its link to severe early postoperative pain. Enhancing rehabilitation protocols and pain management strategies has a major influence on the results of the surgery.

Aims and Objectives: This study compares the duration of motor block, the time it takes for sensory block to start, the duration of sensory block to start, the adverse effects of drugs in two groups, post-operative analgesia and the amount of time it takes to take the first dose of analgesic needed during the recovery period.

Methods: This is a double-blinded randomized and comparative study for which 60 patients were selected out of which 30 patients had in group BD and 30 patients had in group BF. Patients were allocated into 2 groups: group-BD (0.25% bupivacaine 15 ml and dexmedetomidine-1 ml, i.e., 50 micrograms)- 30 patients and group-BF (0.25% bupivacaine 15 ml and fentanyl-1 ml, i.e., 50 micrograms)-30 patients and compared.

Results: There was a statistically significant difference ($p<0.0001$) in the mean length of sensory block, motor block, and mean time commencement of sensory block between the two groups.

Conclusion: The study concludes that dexmedetomidine, when used as an adjuvant to epidural bupivacaine, exhibits a quick start of sensory block, a shorter time to reach maximal sensory level, a longer duration of analgesia, and a longer duration of motor blockade than fentanyl.

Keywords: Epidural Anesthesia, Dexmedetomidine, Single-Shot, Fentanyl, Bupivacaine.

Introduction

An injection of a medication or contrast agent is made into the spinal cord's epidural space during an epidural administration (derived from the Ancient Greek ἐπί, "on, upon" + dura mater). Drug injections through a catheter inserted into the epidural space are commonly used in epidural procedures. Because the injection prevents impulses from traveling through nerve fibers in or near the spinal cord, it may cause a loss of sensation, including the perception of pain. The first "single-shot" lumbar epidural anesthesia technique was created in 1921 by Fidel Pagés, a Spanish military surgeon (1886-1923).[1] A local anesthetic medication is injected into the cerebrospinal fluid as part of the spinal anesthesia technique. This method and epidural anesthesia are somewhat similar, and many laypeople mistake the two for one another. Notable variations consist of: The area inside the bony spinal canal that is immediately outside the dura mater is known as the epidural space ("dura"). The arachnoid mater, or "arachnoid" membrane, is in touch with the dura's inner surface.[2] While spinal injections are usually carried out below the second lumbar vertebral body to prevent piercing and subsequently harming the spinal cord, epidural injections can be carried out anywhere along the vertebral column (cervical, thoracic, lumbar, or sacral).[3] While spinal anesthesia is often administered as a single shot, epidural medicine delivery can be sustained post-operatively (and re-dosed intra-operatively) via a catheter.

Although it must be increased to be adequate for surgery, an epidural injection or infusion for pain management (during delivery, for example) is less likely to result in muscular atrophy.[4] In addition to general anesthesia, the anesthetist may employ epidural analgesia. This could lessen the need for narcotic painkillers for the patient. This can be used for many different types of surgery, including general surgery (like a laparotomy), vascular surgery (like an open

aortic aneurysm repair), orthopaedic surgery (like a hip replacement), and gynecological surgery (like a hysterectomy).[5] Compared to analgesia, anesthesia requires a much higher dosage.[6] For postoperative analgesia, following a procedure in which general anesthesia is used in conjunction with or instead of the epidural method as the only anesthetic. An individual can add sporadic doses of pain medicine through an epidural catheter to an epidural infusion by using a PCEA (Patient-Controlled Epidural Analgesia) infusion pump.[7] Epidural procedures are most appropriate for analgesia anywhere in the lower body and as high as the chest since the epidural space becomes more hazardous and harder to access as one ascends the spine. Since sensory innervation for the head originates directly from the brain via cranial nerves rather than from the spinal cord via the epidural space, they are typically significantly less effective for analgesia for the neck, arms, or head.[8-12]

Aims and Objectives

This study compares the duration of motor block, the time it takes for sensory block to start, the time it takes for sensory block to start, the duration of sensory block to start, the adverse effects of drugs in two groups, and post-operative analgesia.

Material and Methods

This is a double-blinded, randomized, and comparative study that was conducted in the orthopaedic operation theater, post-operative orthopaedic room, and postoperative ward of a Tertiary care teaching Hospital . After obtaining written informed consent, 60 patients of ASA physical status I and II aged between 45 and 75 years of either gender scheduled for total hip replacement surgery under epidural anaesthesia were included. The study period was approximately one and a half years. The sample size was sixty as the total number of patients, and they were allocated as group BD (0.25% bupivacaine 15 ml and dexmedetomidine -1 ml, i.e., 50 micrograms)-30 patients and group BF (0.25% bupivacaine 15 ml and fentanyl 1 ml, i.e., 50 micrograms)-30 patients. The total volume of study drugs was kept at 16 ml in both groups.

Inclusion Criteria and Exclusion Criteria

ASA physical status I and II, aged between 45 and 75 years of either gender, were included in the study. The pregnant patients, patients on anticoagulants, having sepsis or local site infection, or with known cardiovascular, renal, or hepatic diseases or with diabetes mellitus were excluded.

Patients having other contraindications for epidural anaesthesia a history of opioid dependence, or neurological disorders were excluded from the study, along with patients with a known history of allergy to the drugs under study. ASA physical status III and more were also excluded.

Study Design

This is a double-blinded randomized and comparative study using study tools such as an IV cannula, transfusion set, multi-channel monitor, epidural kit, bupivacaine injection (0.25%), dexmedetomidine injection, and fentanyl injection. The parameters to be monitored are non-invasive blood pressure, saturation of oxygen, pulse rate, electrocardiogram, and respiratory rate.

Study Technique

60 patients of either sex, with American Society of Anaesthesiologists (ASA) physical status I and II, aged 45 to 75, who were scheduled for elective total hip replacement under epidural anesthesia in a year and a half, were enrolled for this prospective double-blind randomized study after receiving approval from the Institutional Ethical Committee and obtaining written informed consent from patients. Prior to being included in the trial, patients received an explanation of the sensory and motor evaluation procedure. Patients were randomly assigned to two groups of thirty each, based on a computer-generated number. Group BD patients received an epidural study solution containing 15 milliliters of bupivacaine 0.25% with 1 milliliter (50 microgram) of dexmedetomidine, while group BF patients received the same epidural study solution containing 15 milliliters of bupivacaine 0.25% with 1 milliliter (50 microgram) of Fentanyl, with a total volume of 16 milliliters for both groups. In order to provide anesthesia up to T 10 dermatome, this volume of local anesthetics was administered. An anesthesiologist who is blind to the study protocol and not involved in additional data gathering or patient assessment provided the medication. Routine non-invasive blood pressure, heart rate, ECG (Electrocardiogram), and finger pulse oxymeter monitoring began as soon as the patient entered the operating room. Epidural anesthesia was given under aseptic conditions while the patient was seated at the L3–4 or L4-5 interspace using an 18–G Tuohy needle and the loss of resistance approach. An epidural catheter was placed five centimeters into the epidural space and fastened using the Tuohy needle's bevel facing cephalically. Aspiration of blood or CSF was used to verify the catheter's location. Patients were placed in a supine position and given a test dose of 60 mg (3 ml) lidocaine and 1:200,000 epinephrine to determine if intrathecal or intravenous injection was used. After three minutes, the patients received the study solution, provided that the intrathecal and intravenous injection test doses were negative.

The onset of sensory block was assessed by the bilateral pin prick method. The modified Bromage scale (0 = no power impairment and able to raise straight leg; 1 = unable to raise straight leg but able to flex knee; 2 = unable to flex knee; 3 = unable to flex ankle and foot—no movements) was used to

measure the motor blockade at 5, 10, 15, 20, 25, and 30-minute intervals after epidural administration of the drug. The end points were the onset of sensory analgesia at t10, the complete establishment of motor blockade, the time to two segmental dermatome regressions of analgesia level, and the time to complete recovery. The Ramsey sedation scale (1 = awake, conscious, no sedation; 2 = calm and composed; 3 = awake on verbal command; 4 = brisk response to moderate tactile stimulation; 5 = awake on violent shaking; 6 = unarousable) was used to grade the level of sedation. Before the procedure began and every 20 minutes thereafter, the patient's sedation score was recorded.

Cardio-respiratory parameters of heart rate, blood pressure, and SpO2 were monitored continuously and recorded before (baseline) and every 30 min after epidural block performance until the end of surgery. Intraoperative supplemental oxygen was given. Hypotension was defined in this trial as a drop in systolic blood pressure of more than 20% of the baseline value or less than 100 mm Hg. Patients were treated with volume expansion and, if necessary, incremental doses of mephentermine (3–6 mg). Intravenous atropine (0.2 mg) was used to treat bradycardia (heart rate <55/min). During total hip replacement, respiratory depression and post-epidural shivering may occur. It was carefully observed, recorded, and managed symptomatically.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet for statistical analysis, and SPSS 24.0 and GraphPad Prism version 5 were used for further analysis. For numerical variables, the data was described as mean and standard deviation; for categorical variables, it was count and percentages. For a mean difference, independent or unpaired samples were used in two-sample t-tests. Any statistical hypothesis test in which, in the event that the null hypothesis is true, the sampling distribution of the test statistic is chi-squared is known as a chi-squared test ($\chi 2$ test). The term 'chi-squared test' is frequently used interchangeably with Pearson's chi-squared test, without more explanation. Fischer's exact test or the chi-square test were used, depending on the situation, to compare unpaired proportions.

Results

In group BD, the median age was 59.00 years, while the mean age (mean±SD) of the patients was 59.0667±7.0756 years, with a range of 48.00-75.00 years. The patients in group BF ranged in age from 47.00 to 74.00 years, with a mean age of 60.8667±6.1124 years and a median age of 60.00 years. The mean age difference between the two groups did not reach statistical significance. As a result, three groups' ages were matched ($p = 0.2961$).In group BD, there were 16 (53.3%) and 14 (46.7%) female patients. Fifteen patients in group BF were female, and fifteen patients were male. In two groups, there was no statistically significant gender association ($p = 0.7961$).

The mean time of sensory block onset in the two groups is shown in Table 1 and is statistically significant ($p = 0.0001$). In group BD, the median time of sensory block onset was 7.9 minutes, whereas the mean (mean±SD) of patients was 7.9267±1.5458 minutes, with a range of 5.40-10.80 minutes. The median time of sensory block onset for patients in group BF was 9.40 minutes, and the mean (mean±SD) was 9.7617±1.8435 minutes, with a range of 5.40-13.40 minutes. There was a statistically significant difference in the meantime of sensory block onset between the two groups ($p = 0.0001$).

Table 1 demonstrates that there was statistical significance ($p<0.0001$) in the meantime onset of motor block in both groups. In group BD, the median time of motor block onset was 19.0500 minutes, and the mean (mean±SD) of patients was 19.7400±3.0447 minutes, with a range of 14.9000 -25.4000 minutes. The patients in group BF experienced a mean time onset of motor block of 23.2933±2.6405 minutes, with a range of 17.7000-27.4000 minutes and a median of 24.1000 minutes. There was a statistically significant difference in the meantime onset of motor block between the two groups ($p<0.0001$). The mean length of sensory block in both groups was found to be statistically significant ($p<0.0001$), as indicated by Table 2. In group BD, the median duration of sensory block was 141.00 minutes, and the mean (mean±SD) of patients was 136.7333±16.2352 minutes, with a range of 100.00–159.00 minutes. The patients in group BF experienced a mean sensory block duration (mean±SD) of 104.2333±9.0770 minutes, with a range of 89.00-120.00 minutes and a median of 104.00 minutes. There was a statistically significant difference in the mean duration of sensory block between the two groups ($p<0.0001$).

Table 2 demonstrates that there was statistical significance ($p<0.0001$) in the mean duration of motor block in both groups. The median motor block duration in group BD was 141.00 minutes, and the mean (mean±SD) of patients was 137.5333 ±16.0768 minutes, with a range of 100.00–159.00 minutes (Table 2). The patients in group BF experienced a mean motor block duration (mean±SD) of 104.1667±9.4434 minutes, with a range of 89.00-120.00 minutes and a median of 103.00 minutes. There was a statistically significant difference in the mean duration of motor block between the two groups ($p<0.0001$).

Table 3 shows that 16.7% of group BF experienced pruritus as an adverse reaction, which was substantially greater ($p = 0.0195$). Adverse reactions in the two groups were statistically significantly associated

(p = 0.0195). The statistical significance (p<0.0001) was observed in the mean difference between the two groups' post-op analgesia time taken (Table 4).

Table 1:

	Number	Mean	SD	Minimum	Maximum	Median	P-Value
Group-BD	30	7.9267	1.5458	5.4000	10.8000	7.9000	0.0001
Group- BF	30	9.7617	1.8435	5.4000	13.4000	9.4000	
Time Onset of Sensory Block Two Groups							
	Number	**Mean**	**SD**	**Minimum**	**Maximum**	**Median**	**P-Value**
Group-BD	30	19.7400	3.0447	14.9000	25.4000	19.0500	<0.0001
Group- BF	30	23.2933	2.6405	17.7000	27.4000	24.1000	
Distribution of Mean Time Onset of Motor Block in Two Groups							

Table 2:

	Number	Mean	SD	Minimum	Maximum	Median	P-Value
Group-BD	30	136.7333	16.2352	100.0000	159.0000	141.0000	<0.0001
Group-BF	30	104.2333	9.0770	89.0000	120.0000	104.0000	
Distribution of Mean Duration of Sensory Block in Two Groups							
	Number	**Mean**	**SD**	**Minimum**	**Maximum**	**Median**	**P-Value**
Group-BD	30	137.5333	16.0768	100.0000	159.0000	141.0000	<0.0001
Group-BF	30	104.1667	9.4434	89.0000	120.0000	103.0000	
Distribution of Mean Duration Motor Block in Two Groups							

Table 3: Distribution of Adverse Reaction in Two Groups

Group			
Adverse Reaction	**Group-BD**	**Group-BF**	**Total**
Nil	30	25	55
Row %	54.5	45.5	100.0
Col %	100.0	83.3	91.7
Pruritus	0	5	5
Row %	0.0	100.0	100.0
Col %	0.0	16.7	8.3
Total	30	30	60
Row %	50.0	50.0	100.0
Col %	100.0	100.0	100.0
Chi-square value: 5.4545; p-value: 0.0195			

Table 4: Distribution of Mean Post-Op Analgesia Time Taken in Two Groups

		Number	Mean	SD	Minimum	Maximum	Median	P-Value
Post-op Analgesia taken	Group-BD	30	165.9000	13.3839	120.0000	184.0000	166.5000	<0.0001
	Group-BF	30	114.5000	11.3768	94.0000	130.0000	118.0000	

Discussion

The current investigation was carried out at Tertiary care teaching Hospital. Using the previously stated criteria, 60 patients were chosen; 30 of them belonged to group-BD and 30 to group-BF. Patient numbers were randomly assigned by a computer into two groups: group-BD consisted of 30 patients, and group-BF consisted of 30 patients. Group-BD consisted of 0.25% bupivacaine 15 ml and 1 ml dexmedetomidine i.e., 50 micrograms. According to Arnab Paul et al.,[13] the mean age of group BD was 45.27±10.52 years, while group BF's mean age was 47.2±8.29 years. The mean age difference between the two groups did not reach statistical significance. In group BD, the median age was 59.00 years, while the mean age (mean±SD) of the patients was 59.0667±7.0756 years, with a range of 48.00-75.00 years.

The patients in group BF ranged in age from 47.00 to 74.00 years, with a mean age of 60.8667 ± 6.1124 years and a median age of 60.00 years. The mean age difference between the two groups did not reach statistical significance. 171 patients had females in group-D, and 166 patients had females in group-F, according to Soliman R et al.'s research.[14] 42 patients in group F and 43 patients in group D both had males. No statistical significance was found in that.

The male to female ratio was not statistically significant, as demonstrated by Arnab Paul et al.[13] In group BD, we discovered that 16 patients (53.3%) had males and 14 patients (46.7%) had females. Fifteen patients in group BF were female, and fifteen patients were male. In two groups, there was no statistically significant gender association (p = 0.7961). According to Arnab Paul et al., the start of sensory block occurred in group BD in 7.5±1.25 minutes and group BF in 8.9±1.52 minutes. They discovered that there was a statistically significant difference in the meantime beginning of sensory block between the two groups. However, as demonstrated by Gupta K et al.,[15] the onset of sensory block (min) was 7.25±2.3 for group LD and 9.27±2.79 for group LF. It was discovered that there was no statistically significant difference in the meantime onset of sensory block between the two groups. The median time of 7.9 minutes was observed in group BD, and the mean±standard deviation of the patients' sensory block onset was 7.9267±1.5458 minutes, with a range of 5.40-10.80 minutes. The median time of sensory block onset for patients in group BF was 9.40 minutes, and the mean (mean±SD) was 9.7617±1.8435 minutes, with a range of 5.40-13.40 minutes. There was a statistically significant difference in the meantime of sensory block onset between the two groups (p = 0.0001).

Time to obtain total motor block (min) was 19.65±3.57 mins in group-BD and 21.9±3.59 mins in group BF, according to Arnab Paul et al.[13] They discovered that there was a statistically significant difference in the meantime start of motor block between the two groups. Time to acquire total motor block (min) was 19.27±4.7 min in group-LD and 22.78±5.5 min in group LF, according to Gupta K et al.[15] They discovered that there was a statistically significant difference in the meantime beginning of sensory block between the two groups.

The patients' mean time of motor block onset (mean±SD) in the current study was 19.7400±3.0447 mins, with a range of 14.9000-25.4000 mins. The median for group BD was 19.0500 mins. The patients in group BF experienced a mean time onset of motor block of 23.2933±2.6405 minutes, with a range of 17.7000-27.4000 minutes and a median of 24.1000 minutes. There was a statistically significant difference in the meantime onset of motor block between the two groups (p<0.0001). According to Gupta K et al.,[15] the duration of sensory analgesia in groups LD and LF was found to be 187.7±6.9 and 146.7±8.3 minutes, respectively. They discovered that there was a statistically significant difference in the mean total duration of sensory analgesia between the two groups. According to Arnab Paul et al.,[13] the duration of sensory analgesia in groups BD and BF was found to be 380.32±35.93 and 315.16±25.39 minutes, respectively. They discovered that there was a statistically significant difference in the mean total duration of sensory analgesia between the two groups.

The median duration of sensory block in group BD was determined to be 141.00 minutes, whereas the mean (mean±SD) of patients was 136.7333±16.2352 minutes, with a range of 100.00-159.00 minutes. The patients in group BF experienced a mean sensory block duration (mean±SD) of 104.2333± 9.0770 minutes, with a range of 89.00-120.00 minutes and a median of 104.00 minutes. There was a statistically significant difference in the mean duration of sensory block between the two groups (p<0.0001). Time until duration of motor block (min) was 248±34.85 mins in group-BD and 220±25.93 mins in group BF, according to Arnab Paul et al.[13] They discovered that there was a statistically significant difference in the mean time to duration of motor block between the two groups.

According to Gupta K et al.,[15] the duration of the motor block was 167.4±21 minutes for the LD group and 125.6±36 minutes for the LF group. They discovered that there was a statistically significant difference between the mean time to duration of motor block in the two groups. The average motor block duration (mean±SD) for the patients was determined to be 137.5333±16.0768 minutes, with a range of 100.00–159.00 minutes. The median time in group BD was found to be 141.00 minutes. The patients in group BF experienced a mean motor block duration (mean±SD) of 104.1667 ± 9.4434 minutes, with a range of 89.00-120.00 minutes and a median of 103.00 minutes. There was a statistically significant difference in the mean duration of motor block between the two groups (p<0.0001). Thirty-three patients in group F experienced pruritus as an adverse reaction, which was considerably greater (Soliman R et al., 2014).

As an adverse event, pruritus was reported by 5 (16.7%) in group BF, which was considerably greater (p = 0.0195). The mean difference between the two groups' post-operative analgesia was statistically significant (p<0.0001).After the operation was finished, we discovered that neither of the two groups had any respiratory depression. According to Arumugam et al.,[16] patients undergoing infraumbilical procedures can safely substitute epidural anesthesia for general anesthesia. The purpose of this study was to determine how well clonidine worked as an adjuvant for levobupivacaine, a bupivacaine derivative in the S (-) enantiomer. Randomization was used to divide the 100 ASA grade I and II patients receiving infraumbilical operations into two groups: L and LC. 0.5% levobupivacaine (1.5 mg/kg) was given to group L, while 0.5% levobupivacaine (1.5 mg/kg) plus clonidine (2µg/kg) was given to group LC. Both groups' VAS scores, sensory and motor blockade onset times, anesthesia and analgesia durations, and analgesia durations were

noted.

Vidhi Mahendru et al.[17] found that various adjuvants are being used with local anaesthetics for prolongation of intraoperative and postoperative analgesia. Dexmedetomidine, the highly selective a2 adrenergic agonist is a new neuraxial adjuvant gaining popularity. Hanoura SE et al.[18] found that a study was designed to evaluate the effect of adding dexmedetomidine to a regular mixture of epidural drugs for pregnant women undergoing elective caesarean sections with special emphasis on their sedative properties, ability to improve quality of intraoperative, postoperative analgesia, and neonatal outcome.

Conclusion

In patients undergoing total hip replacement, dexmedetomidine is a better adjuvant to fentanyl for intraoperative analgesia. Epidural bupivacaine with dexmedetomidine provided better adequate surgical anaesthesia and stable cardio-respiratory parameters with prolonged postoperative analgesia for total hip replacement but no difference was elicited as far as the level of sensory block is concerned between dexmedetomidine and fentanyl. Compared to fentanyl, dexmedetomidine offers superior postoperative analgesia, lowers the need for postoperative opioids, and lessens complications such as pruritis. Both adjuvants reduced the epidural dose of bupivacaine and potentiated its efficacy for total hip replacement. The study comes to the conclusion that dexmedetomidine, when used as an adjuvant to epidural bupivacaine, exhibits a faster start of sensory block, a shorter time to reach maximal sensory level, a longer duration of analgesia, and a longer duration of motor blockade than fentanyl. One of the study's shortcomings is the limited sample size. To compare the use of fentanyl and dexmedetomidine as adjuncts to hyperbaric bupivacaine in epidural anesthesia in tertiary care facilities, more extensive research is advised.

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