Original Article

Comparison of Intrathecal Bupivacaine with Additives Buprenorphine Versus Bupivacaine with Dexmedetamidine for Postoperative Analgesia in Lower Limb Surgeries

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ABSTRACT

Objective: This study compared intrathecal bupivacaine with additive buprenorphine versus bupivacaine with dexmedetomidine in lower limb surgery

Study Design: Randomized Controlled Trial study.

Place and Duration of Study: This study was conducted at the Department of Anesthesia, DHQ Teaching Hospital Gujranwala from for 12 months from 30-09-2021 to 29-09-2022.

Methods: After taking informed consent and demographic detail 60 patients were enrolled. Patients were divided randomly into 02 groups. Group 1, patients were given 60µg of buprenorphine with 2cc (15mg) of 0.75 % heavy bupivacaine. Group 2, patients were given 5µg of dexmedetomidine with 2cc (15mg) of 0.75 % heavy bupivacaine. The duration between start of spinal anaesthesia till the first dose of rescue analgesia recorded as duration of analgesia.

Results: From buprenorphine group the mean duration of analgesia of the patients was 234.67±13 minutes whereas in group dexmedetomidine the mean duration of analgesia of the patients was 275.17±29.77 minutes (p-value=<0.001). From buprenorphine, VAS score was 3.87±0.63 while with dexmedetomidine group VAS score was 3.90±0.66 (p =0.842). From buprenorphine group the mean rescue analgesia was 4.40±0.56 mg while from dexmedetomidine group the mean rescue analgesia was 4.33±0.55 mg (p-value=0.644).

Conclusion: These findings suggest that while dexmedetomidine may provide prolonged analgesia, both adjuvants effectively manage postoperative pain, offering viable options for spinal anesthesia in lower limb procedures.

Key Words: Intrathecal bupivacaine, Dexmedetomidine, Buprenorphine, Lower Limb Surgeries

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INTRODUCTION

Although bupivacaine is the most often used long-acting local anesthetic,[1] the addition of opioids may enhance the quality of anesthesia and analgesia by reducing the time it takes for sensory block to develop, extending the length of sensory block & hence the duration of analgesia into the postoperative phase.[2]

Bupivacaine is a widely used local anesthetic for spinal anesthesia, available in both hyperbaric and isobaric formulations.

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The choice between these two solutions remains a topic of debate, particularly regarding the predictability of the level of analgesia they provide.

Hyperbaric Bupivacaine, which contains added dextrose to increase its specific gravity, tends to follow gravitational movement in the cerebrospinal fluid (CSF), leading to a more controlled and predictable spread of anesthesia.[3]

In contrast, isobaric Bupivacaine, which has a density similar to CSF, exhibits a more variable distribution, as it is influenced by factors like patient positioning and CSF dynamics. While hyperbaric solutions offer greater control over the anesthetic spread, isobaric solutions may provide a more gradual onset and potentially longer duration of action. The addition of dextrose to local anesthetic solutions plays a crucial role in modifying their pharmacokinetic and pharmacodynamic properties, ultimately impacting the effectiveness and reliability of spinal anesthesia.[4]

The ideal intrathecal medication for spinal anesthesia should provide an optimal balance between effective

anesthesia, prolonged postoperative pain relief, and minimal side effects.[5] Bupivacaine, a long-acting amide local anesthetic, is widely preferred due to its reliable sensory and motor blockade, hemodynamic stability, and extended duration of action. Its prolonged analgesic effect makes it particularly suitable for procedures requiring sustained postoperative pain control, reducing the need for additional analgesics. When used alone, Bupivacaine offers adequate anesthesia, but combining it with adjuvants like opioids (e.g., fentanyl, morphine) or alpha-2 agonists (e.g., dexmedetomidine, clonidine) can enhance its efficacy, prolong analgesia, and reduce postoperative opioid consumption.[6]

In subarachnoid block, opioids have been used with Bupivacaine to extend the effect, increase analgesia quality, and reduce the need for post-operative analgesics. The reason for combining opioids & local anesthetics is that this combination will relieve pain by acting on two separate sites: local anesthetics on the nerve axon & opioids on the spinal cord receptor site.

Through literature, it has been noticed that dexmedetomidine with bupivacaine is more effective in improving duration of analgesia than buprenorphine. But not much work has been done in this regard. Moreover, no local evidence found in literature which could help us in implementing better drug to reduce postoperative pain and less analgesia consumption by improving duration of analgesia requirement. So, we planned to conduct this study to obtained more exact & reliable results which can be implemented in local setting. So, in future, the results of this study will help us to confirm the results of previous studies and will improve our practice and local guidelines.

METHODS

This study was conducted in the Department of Anesthesiology at DHQ Hospital, Gujranwala, over a 12-month period following the approval of the study synopsis by the institutional review board. The sample size was determined using a 95% confidence level and 80% power of the test, based on data from previous studies evaluating the mean duration of analgesia following spinal anesthesia.

Patients between the ages of 18 and 70 years who were scheduled to undergo lower limb surgeries under spinal anesthesia were considered eligible for inclusion in the study. Patients classified as American Society of Anesthesiologists (ASA) III or IV, those with a known allergy or hypersensitivity to the study drugs, or those with contraindications to spinal anesthesia were excluded from participation. Before enrollment, detailed informed consent was obtained from each participant. Additionally, baseline demographic and clinical data such as name, age, gender, body mass index (BMI), ASA classification, and the type of surgical procedure were documented systematically.

Participants were randomly assigned to one of two groups:

- Group 1 received 60 μg of buprenorphine along with 2 cc (15 mg) of 0.75% hyperbaric bupivacaine.
- Group 2 received 5 μg of dexmedetomidine in combination with 2 cc (15 mg) of 0.75% hyperbaric bupivacaine.

Before the administration of spinal anesthesia, standard preoperative monitoring was initiated, including electrocardiography (ECG), non-invasive blood pressure (NIBP) monitoring, and pulse oximetry (SpO_2). Under strict aseptic conditions, spinal anesthesia was administered to each patient in a sitting position at the L4-L5 interspace using a 25G Quincke spinal needle. After successful drug administration, the exact time of surgery completion was recorded. Following the procedure, all patients were transferred to the postoperative recovery unit, where they were closely monitored for 24 hours for any adverse effects or complications.

To evaluate the effectiveness of analgesia, pain intensity was assessed using the Visual Analogue Scale (VAS) at regular intervals. The time to first onset of significant pain (VAS score >4) was carefully documented. Once the pain threshold exceeded this level, rescue analgesia in the form of Nalbuphine (0.1 mg/kg) was administered. The total duration of analgesia was measured as the interval between the administration of spinal anesthesia and the first request for additional pain relief.

All relevant patient data, including pain scores, time to rescue analgesia, and any observed side effects, were meticulously recorded in a structured proforma for subsequent analysis.

Data analysis was performed using SPSS version 21. Continuous variables, such as age, BMI, and duration of analgesia, were expressed as mean ± standard deviation (SD), while categorical variables, including gender, ASA classification, and surgical procedure type, were presented as frequency and percentages. To compare the mean duration of analgesia between the two study groups, an independent sample t-test was applied.

To address potential confounding factors, data stratification was carried out based on age, gender, BMI, ASA status, and type of surgery. Following stratification, additional post-stratification independent sample t-tests were performed to ensure the robustness of the comparative analysis.

This comprehensive methodology ensured that the study adhered to scientific rigor and statistical accuracy, allowing for reliable assessment of the effectiveness of buprenorphine and dexmedetomidine as adjuvants in spinal anesthesia for lower limb surgeries.

RESULTS

Of total 60 patients, mean age was 46.97±11.78 years with minimum 25 and maximum ages 69 years. From buprenorphine group the mean age was 45.93±10.99 years &from dexmedetomidine group the mean age was 48.00±12.62 years.

In this study ASA I patients were 39(65%) whereas ASA II patients were 21(35%). In this study 21(70%) patients were from ASA I in buprenorphine group and 18(60%) patients were from ASA I in dexmedetomidine group. Similarly, 09(30%) patients were from ASA II in buprenorphine group and 12(40%) patients were from ASA II in dexmedetomidine group. Comparison of ASA between study groups showed insignificant difference statistically.
i.e. p-value = 0.417.
According to this study dynamic hip screw and inter-medullary surgical procedure were done in 12(20%) patients respectively, distal locking plate and external fixator tibia were done in 5(8.33%) patients respectively, k nail femur failure done in 9(15%) patients, femoral nail anti-rotation procedure done in 11(18.33%) patients and tension wire binding noted in 4(6.67%) patients.

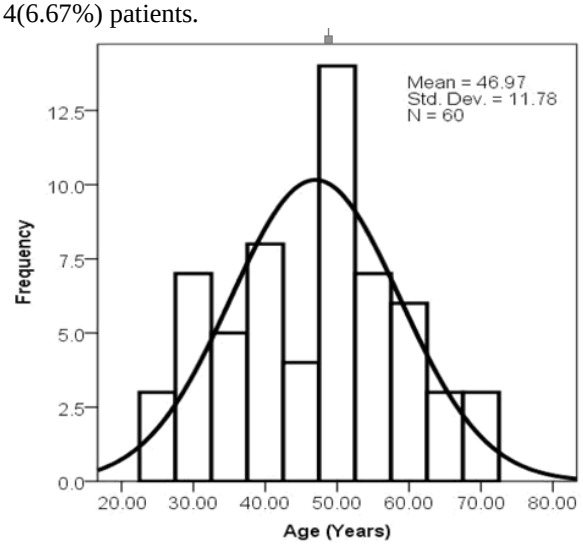

Figure No. 1: Distribution of Age (Years)

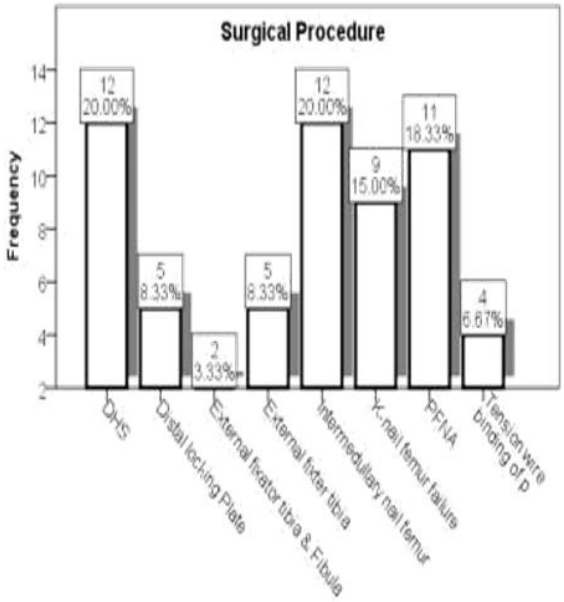

Figure No. 2: Distribution of Surgical Method

From buprenorphine group dynamic hip screw procedure was done in 5(16.7%) patients whereas from dexmedetomidine group the dynamic hip screw procedure was done in 7(23.3%) patients, p-value = 0.545.

Table No. 1: Comparison of Demographic and Clinical Variables between Study Group

Variable	Bup Group (n=30)	Dex Group (n=30)	p-value
Age (years) (Mean ± SD)	45.93 ± 10.99	48.00 ± 12.62	0.502
Gender			
Male	15 (50%)	14 (46.7%)	0.796
Female	15 (50%)	16 (53.3%)	
ASA Status			
ASA I	21 (70%)	18 (60%)	0.417
ASA II	9 (30%)	12 (40%)	
Surgical Procedure			
Dynamic Hip Screw	5 (16.7%)	7 (23.3%)	0.545
Distal Locking Plate	3 (10.0%)	2 (6.7%)	
External Fixator (Tibia & Fibula)	0 (0.0%)	2 (6.7%)	
External Fixator (Tibia)	3 (10.0%)	2 (6.7%)	
Intramedullary Nail (Femur)	6 (20.0%)	6 (20.0%)	
K-Nail Femur Failure	6 (20.0%)	3 (10.0%)	
Femoral Nail Anti-Rotation	4 (13.3%)	7 (23.3%)	
Tension Wire Binding (Patellar)	3 (10.0%)	1 (3.3%)	
Duration of Analgesia (minutes) Mean ± SD	234.67 ± 13.00	275.17 ± 29.77	<0.001
Pain on VAS (Mean ± SD)	3.87 ± 0.63	3.90 ± 0.66	0.842
Rescue Analgesia (mg) (Mean ± SD)	4.40 ± 0.56	4.33 ± 0.55	0.644

The mean duration of analgesia of the patients was 254.92±30.59 minutes with minimum and maximum duration of 209 & 323 minutes respectively. From buprenorphine group the mean duration of analgesia of the patients was 234.67±13 minutes whereas in

dexmedetomidine group was 275.17±29.77 minutes. Comparison of duration of analgesia (minutes) between study groups showed significant difference statistically. i.e. p-value < 0.001. The average pain on VAS was 3.88±0.64 with minimum and maximum pain scores of 3 & 5 respectively.

From buprenorphine group the mean pain on VAS score was 3.87±0.63 while from dexmedetomidine group the mean pain on VAS score was 3.90±0.66. Comparison of pain on VAS between study groups showed insignificant statistically. i.e. p-value=0.842. The average rescue analgesia was 4.37±0.55 mg with minimum and maximum rescue analgesia of 3 & 5 mg respectively.

Comparison of rescue analgesia between study groups showed insignificant statistically. i.e. p-value=0.644. In patients having age ≤ 50 years; in buprenorphine group the mean duration of analgesia of the patients was 235.50±14.16 minutes and in dexmedetomidine its mean value was 273.59±35.63 minutes (p-value=<0.001).

In patients having age > 50 years; in buprenorphine group the mean duration of analgesia of the patients was 233±10.79 minutes and in dexmedetomidine its mean value was 277.23±21.00 minutes (p-value=<0.001). In male patients; in buprenorphine group the mean duration of analgesia of the patients was 233.53±12.94 minutes and in dexmedetomidine its mean value was 280.07±24.95 minutes (p-value=<0.001). In female patients; in buprenorphine group the mean duration of analgesia of the patients was 235.80±13.42 minutes and in dexmedetomidine its mean value was 270.87±33.64 minutes (p-value=0.001).

DISCUSSION

Multiple studies have demonstrated that intrathecal dexmedetomidine provides a significantly longer duration of analgesia compared to buprenorphine when used as an adjuvant with hyperbaric bupivacaine for lower limb surgeries. Recent studies have directly compared the analgesic efficacy of buprenorphine versus dexmedetomidine when added to intrathecal bupivacaine for lower limb surgeries, providing valuable insights into their relative performance. These investigations have focused on parameters such as duration of analgesia, onset of sensory and motor blockade, and hemodynamic stability.[7]

A study by Rajni Gupta et al. demonstrated that dexmedetomidine as an intrathecal adjuvant to bupivacaine significantly prolonged both sensory and motor block duration compared to fentanyl. The mean time for sensory regression to S1 was notably longer in the dexmedetomidine group (D) (476 ± 23 minutes) than in the fentanyl group (F) (187 ± 12 minutes), indicating a more sustained analgesic effect with dexmedetomidine. (P<0.001).[8]

A study by Al-Mustafa et al. reported that the higher doses of DEX with bupivacaine resulted in a more extended sensory and motor block, contributing to better postoperative analgesia.[9] The duration time of analgesia with dexmedetomidine is proportionate to its dosage, according to a study by Eid et al.[10]

Rajan US et al resulted in their study across the two groups, the average time of start of sensory & motor block, 2 segment regression & the length of motor block were comparable or not significant statistically. When comparing Buprenorphine to Nalbu-phine with Bupivacaine, the postoperative analgesia duration was considerably longer with Buprenorphine (p0.05).[7] Soumya Samal et al used intrathecal Buprenorphine and Dexmedetomidine for post-operative analgesia & observed that intrathecal Buprenorphine lasts longer than intrathecal Dexmedetomidine without causing significant hemodynamic alterations.[11] Another randomized trial reported that mean duration of analgesia was 210±22.4minutes with buprenorphine and 240±30.2 minutes with dexmedetomidine (p<0.0001).[12]

This discussion highlights the dose-dependent efficacy of Buprenorphine and Dexmedetomidine as adjuvants for prolonged analgesia. Buprenorphine at higher doses (50 µg) provides 6–15 hours of pain relief, while Dexmedetomidine (5 µg) offers ~13.7 hours, making it comparable to mid-range Buprenorphine doses. However, Buprenorphine at ≤50 µg/kg may provide even longer analgesia than Dexmedetomidine. Both agents extend the duration of analgesia beyond that of plain Bupivacaine, but Dexmedetomidine may be associated with fewer side effects in some studies.[13] Given the variability in outcomes, dose selection and surgical context are crucial in optimizing postoperative pain management. Research indicates that dexmedetomidine prolongs analgesia by approximately 40-70% longer than buprenorphine, while also offering a faster onset of sensory and motor blockade.[14-18] Both adjuvants have been shown to effectively extend postoperative pain relief compared to bupivacaine alone, making them valuable choices for optimizing spinal anesthesia outcomes in orthopedic procedures. Additionally, dexmedetomidine has been associated with more stable hemodynamics and fewer side effects, further supporting its potential as a preferred intrathecal adjuvant for prolonged analgesia in surgical settings.[19-21]

CONCLUSION

These findings suggest that while dexmedetomidine may provide prolonged analgesia, both adjuvants effectively manage postoperative pain, offering viable options for spinal anesthesia in lower limb procedures. However, in terms of pain relief and the need for rescue analgesia, both groups demonstrated comparable efficacy.

Limitations of the Study

1. **Short Follow-Up Duration** – Postoperative analgesia was assessed for only 24 hours. Long-term pain relief and potential delayed complications were not evaluated.
2. **Subjective Pain Assessment** – The study relied on the **Visual Analogue Scale (VAS)** for pain assessment, which is inherently subjective and may vary based on individual pain tolerance and perception.
3. **Potential Confounding Factors** – Although data were stratified by age, gender, ASA status, and surgical procedure, other factors such as individual pain thresholds, opioid tolerance, and comorbidities were not accounted for.
4. **Limited Dose and Drug Combinations** – Only one fixed dose of **buprenorphine (60 µg)** and **dexmedetomidine (5 µg)** was used. Different doses or combinations with other adjuvants might yield different outcomes.
5. **No Long-Term Adverse Effect Analysis** – The study focused only on **analgesic duration and pain scores** without assessing potential long-term side effects such as **neurological deficits, respiratory depression, or hemodynamic instability**.
6. **Rescue Analgesia Standardization** – The same rescue analgesia (**Nalbuphine 0.1 mg/kg**) was given to all patients, but individual variations in analgesic requirements were not explored.
7. **Exclusion of ASA III & IV Patients** – The study excluded high-risk patients (ASA III & IV), limiting its applicability to patients with significant comorbidities who might experience different analgesic outcomes.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Salman Athar Qureshi, Faiqa Qurban
Drafting or Revising Critically:	Salman Athar Qureshi, Muhammad Umair Aslam
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

Conflict of Interest: The study has no conflict of interest to declare by any author.

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