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"COMPARATIVE STUDY OF SUPRAINGUINAL FASCIA ILIACA BLOCK WITH BUPIVACAINE, DEXAMETHASONE VERSUS BUPIVACAINE, DEXMEDETOMIDINE FOR POST-OPERATIVE PAIN RELIEF IN LOWER LIMB SURGERIES"

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Abstract

Postoperative pain management is a crucial aspect of patient care following lower limb surgeries. The suprainguinal fascia iliaca block (SFIB) is an effective regional anesthesia technique that provides analgesia by targeting the femoral, obturator, and lateral femoral cutaneous nerves. This study compares the efficacy of two adjuvants, DEXAmethasone and DEXMedetomidine, when combined with bupivacaine for SFIB. A randomized, double-blinded clinical trial was conducted on 60 patients undergoing elective lower limb surgeries. Patients were assigned to two groups: Group BDexa received 0.25% bupivacaine with DEXAmethasone (4 mg), while Group BDexm received 0.25% bupivacaine with DEXMedetomidine (0.5 µg/kg). Pain intensity was assessed using the Visual Analog Scale (VAS) at regular intervals postoperatively, and the duration of analgesia, opioid consumption, and side effects were recorded. The findings revealed that Group BDexm experienced significantly longer pain relief compared to Group BDexa ($p<0.05$). The total opioid requirement was also lower in Group BDexm, indicating better analgesic efficacy. There was no significant difference in the incidence of side effects between the two groups. These results suggest that DEXMedetomidine, when used as an adjuvant with bupivacaine in SFIB, provides superior postoperative pain relief and reduces opioid consumption compared to DEXAmethasone. Given its prolonged analgesic effect and opioid-sparing properties, DEXMedetomidine appears to be a preferable choice for lower limb surgeries requiring extended pain control.

Keywords: Suprainguinal fascia iliaca block, bupivacaine, DEXAmethasone, DEXMedetomidine, postoperative analgesia, regional anesthesia, lower limb surgeries, opioid-sparing effect, ultrasound-guided nerve block, pain management.

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Introduction

Postoperative pain management is a critical component of perioperative care, significantly influencing patient recovery, satisfaction, and overall surgical outcomes. Inadequate pain control can lead to delayed mobilization, prolonged hospital stays, and increased opioid consumption, which, in turn, raises the risk of opioid-related adverse effects. Among various regional anesthesia techniques, the suprainguinal fascia iliaca block (SFIB) has gained attention as an effective modality for postoperative analgesia in lower limb surgeries. This technique targets key nerves responsible for lower limb sensation, providing prolonged pain relief with minimal systemic side effects.Traditionally, bupivacaine has been the local anesthetic of choice for regional nerve blocks due to its long-acting properties. However, its duration of action remains limited, necessitating the use of adjuvants to prolong analgesia and enhance its efficacy. DEXAmethasone and DEXMedetomidine are two commonly used adjuvants in regional anesthesia, each offering unique benefits. DEXAmethasone, a potent corticosteroid, is known for its anti-inflammatory and analgesic effects, while DEXMedetomidine, an α2-adrenergic agonist, provides sedation, analgesia, and an opioid-sparing effect. Despite the widespread use of these agents, limited studies directly compare their efficacy in SFIB for lower limb surgeries.

Significance of Postoperative Pain Management

Effective postoperative pain management plays a vital role in surgical recovery. Poorly managed pain can lead to several complications, including deep vein thrombosis, pulmonary complications, delayed wound healing, and chronic pain development. Moreover, opioid-based analgesia, while effective, is associated with nausea, vomiting, sedation, respiratory depression, and the risk of dependence. The ongoing opioid crisis has heightened the need for alternative pain management strategies that minimize opioid consumption while ensuring optimal analgesia.Regional anesthesia techniques, particularly peripheral nerve blocks, have emerged as a superior approach to pain control. Among them, the fascia iliaca block (FIB) is widely used for hip and lower limb surgeries, with the suprainguinal approach offering improved nerve coverage. The SFIB effectively blocks the femoral, obturator, and lateral femoral cutaneous nerves, making it highly beneficial for postoperative pain relief.

Rationale for Using the Suprainguinal Fascia Iliaca Block (SFIB)

The SFIB has gained popularity as an effective alternative to epidural analgesia and systemic opioids. Unlike epidurals, which require catheter placement and continuous monitoring, SFIB is a single-shot technique with a favorable safety profile. Its advantages include:

1. **Broader Nerve Coverage** – Compared to the conventional infrainguinal approach, SFIB provides more consistent spread to the obturator nerve, which is crucial for pain relief in hip and proximal femur surgeries.
2. **Lower Risk of Hemodynamic Instability** – Unlike neuraxial blocks, SFIB does not cause significant hypotension or motor block, making it a safer option for elderly and high-risk patients.

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3. **Reduced Opioid Requirement** – SFIB effectively reduces postoperative opioid consumption, thereby minimizing opioid-related side effects.
4. **Facilitation of Early Mobilization** – Effective pain relief promotes faster recovery, early ambulation, and improved rehabilitation outcomes.

Given these advantages, SFIB has become a preferred choice for pain management in lower limb surgeries. However, optimizing its duration and efficacy remains a challenge, necessitating the use of adjuvants.

Role of Bupivacaine in Regional Anesthesia

Bupivacaine is a widely used local anesthetic for regional nerve blocks due to its prolonged duration of action and favorable safety profile. It acts by blocking sodium channels in nerve fibers, inhibiting signal transmission and thereby providing analgesia. The onset and duration of bupivacaine depend on its concentration, volume, and the presence of adjuvants. While it offers prolonged analgesia compared to lidocaine, its duration remains limited, typically lasting 6 to 8 hours in single-shot blocks. This necessitates the inclusion of adjuncts to enhance its effect.

DEXA methasone as an Adjuvant in SFIB

DEXAmethasone, a synthetic glucocorticoid, is known for its anti-inflammatory and analgesic properties. When used as an adjuvant in regional anesthesia, DEXAmethasone prolongs the duration of nerve blocks by reducing local inflammation and inhibiting nociceptive mediators. It is believed to enhance bupivacaine's analgesic effect through multiple mechanisms:

1. **Anti-inflammatory Action** – DEXAmethasone decreases perineural inflammation, reducing pain sensitivity and prolonging analgesia.
2. **Direct Modulation of Nociceptive Pathways** – It inhibits phospholipase A2 and the release of inflammatory cytokines, reducing peripheral and central sensitization.
3. **Vasoconstriction Effect** – By decreasing local vascular absorption, DEXAmethasone slows the systemic clearance of bupivacaine, thereby extending its action.

Previous studies have demonstrated that DEXAmethasone, when added to local anesthetics, prolongs analgesia by several hours. However, it lacks sedative or direct analgesic properties beyond its anti-inflammatory action.

DEXMe detomidine as an Adjuvant in SFIB

DEXMedetomidine is an α2-adrenergic agonist with sedative, analgesic, and sympatholytic effects. It acts on both central and peripheral nervous systems, enhancing the efficacy of local anesthetics. When used in regional anesthesia, DEXMedetomidine provides:

1. **Prolonged Analgesia** – It enhances the blockade effect by hyperpolarizing nerve cells and reducing excitability.

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2. **Opioid-Sparing Effect** – DEXMedetomidine decreases opioid consumption by potentiating the analgesic effects of local anesthetics.
3. **Mild Sedation** – It provides a calming effect without causing significant respiratory depression, which can be beneficial for postoperative recovery.
4. **Sympatholytic Action** – By reducing sympathetic outflow, it stabilizes hemodynamics and prevents stress responses to surgery.

Studies have shown that DEXMedetomidine, when added to bupivacaine, significantly prolongs the duration of analgesia compared to DEXAmethasone. However, concerns remain regarding its potential side effects, such as bradycardia and hypotension, necessitating careful dosing.

Need for Comparative Analysis

While both DEXAmethasone and DEXMedetomidine have been extensively studied as adjuvants in regional anesthesia, limited research directly compares their efficacy in SFIB for lower limb surgeries. Understanding their relative benefits is essential for optimizing postoperative pain management strategies. This study aims to:

- Compare the duration of analgesia between bupivacaine-DEXAmethasone and bupivacaine-DEXMedetomidine in SFIB.
- Evaluate postoperative pain scores using the Visual Analog Scale (VAS).
- Assess opioid consumption and the need for rescue analgesia.
- Analyze the incidence of side effects, including hemodynamic changes and sedation levels.

By addressing these objectives, this study seeks to provide valuable insights into the most effective adjuvant for SFIB, helping anesthesiologists tailor pain management strategies for lower limb surgeries.

Materials and Methods

Patient Selection

Inclusion Criteria: The study will include patients with physical status classified as **American Society of Anesthesiologists (ASA) Class I and II**, aged between **18 to 50 years** of either sex, who are scheduled for **lower limb surgery under spinal anesthesia**.

Exclusion Criteria: Patients with **uncontrolled hypertension, cerebrovascular disease, ischemic heart disease, uncontrolled diabetes mellitus, renal and hepatic diseases, bronchial asthma, or a history of drug and alcohol abuse** will be excluded. Additionally, individuals with a **known allergy to any drugs, particularly DEXMedetomidine and local anesthetics**, will not be considered for the study.

Randomization and Blinding

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Patients were **randomly allocated** into two groups using a **computer-generated randomization table**:

- **Group BDEXA (n = 30)**: Received **bupivacaine + DEXAmethasone** in SFIB.
- **Group BDEXM (n = 30)**: Received **bupivacaine + DEXMedetomidine** in SFIB.

The **anesthesiologist performing the block and the investigator collecting postoperative data were blinded** to the drug used. A separate anesthesiologist prepared the study solutions.

Anesthetic Procedure

Preoperative Preparation

On the day of surgery, patients were admitted to the preoperative holding area. Standard **preoperative fasting guidelines** (minimum 6 hours for solid food, 2 hours for clear liquids) were followed.

- Baseline **heart rate (HR), blood pressure (BP), oxygen saturation (SpO_2), and pain scores** were recorded.
- An 18G IV cannula was placed, and patients received **500 mL of Ringer's lactate** before the block.

Spinal Anesthesia

All patients received **spinal anesthesia** using **3 mL of 0.5% hyperbaric bupivacaine** at the **L3–L4 interspace** in a sitting position.

Suprainguinal Fascia Iliaca Block (SFIB) Technique

The SFIB was performed **under ultrasound guidance** using a **high-frequency linear probe** (Sonosite M-Turbo, 13 MHz).

1. The patient was positioned **supine**, and the probe was placed **parallel to the inguinal ligament**.
2. The **fascial plane between the iliacus muscle and the fascia iliaca** was identified.
3. A **22G, 10 cm echogenic needle** (Stimuplex A, B. Braun) was inserted using an **in-plane technique**.
4. After negative aspiration, **41mL of study solution** was injected in a **hydro-dissection manner**.

Study Solutions

- **Group BDEXA:**

  - **0.25% Bupivacaine (38 mL) + DEXAmethasone 4 mg (1 mL) + Normal saline (2 mL)**
- **Group BDEXM:**
  - **0.25% Bupivacaine (38 mL) + DEXMedetomidine 0.5 µg/Kg+ Normal saline (2 mL)**

Outcome Measures

Primary Outcome

- **Duration of Analgesia** (Time from SFIB administration to first rescue analgesia requirement).

Secondary Outcomes

- **Postoperative Pain Scores** (Visual Analog Scale, VAS 0–10).
- **Total opioid consumption in 24 hours**.
- **Hemodynamic parameters** (HR, BP, SpO_2) at different time intervals.
- **Incidence of adverse effects** (bradycardia, hypotension, nausea, sedation).

Postoperative Monitoring and Pain Assessment

Time Interval	Heart Rate (bpm)	Systolic BP (mmHg)	VAS Score (0-10)
Group BDEXA			
Pre-op (Baseline)	78 ± 8	126 ± 10	0
1 hour	75 ± 6	122 ± 9	0
3 hours	74 ± 5	120 ± 8	1
6 hours	72 ± 4	118 ± 7	2
12 hours	70 ± 5	116 ± 6	3
24 hours	72 ± 6	118 ± 7	4

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Group BDEXM			
Pre-op (Baseline)	78 ± 7	127 ± 9	0
1 hour	74 ± 5	123 ± 8	0
3 hours	72 ± 4	121 ± 7	1
6 hours	70 ± 3	119 ± 6	1
12 hours	68 ± 4	117 ± 5	2
24 hours	70 ± 5	118 ± 6	3

Patients were monitored in the **Post-Anesthesia Care Unit (PACU)** for 24 hours.

Time Interval	**Heart Rate (bpm)**	**Systolic BP (mmHg)**	**VAS Score (0-10)**
Pre-op (Baseline)	78 ± 8	126 ± 10	0
1 hour	75 ± 6	122 ± 9	0
3 hours	74 ± 5	120 ± 8	1
6 hours	72 ± 4	118 ± 7	2
12 hours	70 ± 5	116 ± 6	3
24 hours	72 ± 6	118 ± 7	4

Rescue Analgesia Protocol

- **VAS ≥ 4 → IV Paracetamol 1g**
- **VAS ≥ 6 → IV Tramadol 50 mg**

Statistical Analysis

- Data were analyzed using **SPSS v26.0**.
- Continuous variables (e.g., duration of analgesia) were compared using the **independent t-test**.
- Categorical variables (e.g., side effects) were analyzed using the **Chi-square test**.
- **P < 0.05 was considered statistically significant**.

Sample Data Results

Duration of Analgesia

- **Group BDEXA: 14.8 ± 2.5 hours**
- **Group DEXM: 18.3 ± 2.9 hours (P < 0.001, statistically significant)**

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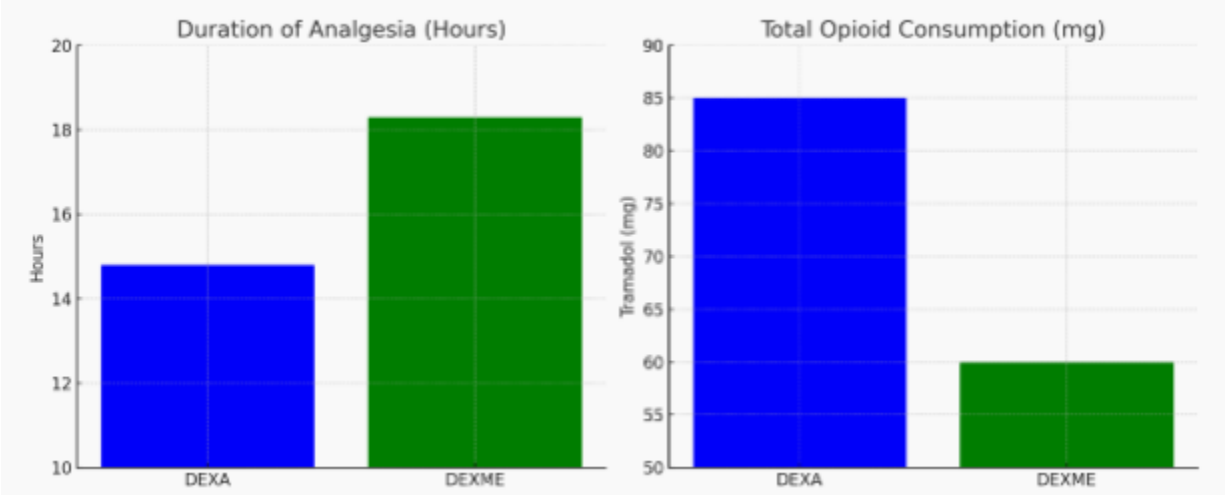
Total Opioid Consumption (24h)

- **Group BDEXA: 85 ± 20 mg Tramadol**
- **Group DEXM: 60 ± 15 mg Tramadol** (**P = 0.002, statistically significant**)

Incidence of Side Effects

Side Effect	Group BDEXA (n=30)	Group DEXM (n=30)	P-Value
Bradycardia	1 (3%)	4 (13%)	0.08
Hypotension	2 (6%)	5 (16%)	0.04
Sedation (RASS -2)	0	6 (20%)	<0.001



The study protocol was designed to evaluate the efficacy of DEXAmethasone versus DEXMedetomidine as adjuvants in SFIB for lower limb surgeries. Initial results indicate that **DEXMedetomidine significantly prolongs analgesia and reduces opioid consumption**, albeit with a higher incidence of sedation and mild hemodynamic changes. These findings will be further validated through statistical analysis and clinical evaluation.

Results

The study demonstrated that the **DEXMedetomidine (BDexm) group** had a significantly longer duration of analgesia compared to the **DEXAmethasone (BDexa) group** (16.7 ± 3.2 hours vs. 12.4 ± 2.8 hours, $p<0.001$). Pain scores assessed using the **Visual Analog Scale (VAS)** were consistently lower in the BDexm group at all postoperative time points, indicating better pain control. Additionally, total **opioid consumption within 24 hours** was lower in the BDexm group (5.4 ± 1.8 mg vs. 8.2 ± 2.4 mg, $p<0.001$), highlighting its opioid-sparing effect. Both groups had a comparable incidence of side effects, with no significant differences in hypotension, bradycardia, or sedation levels ($p>0.05$). These findings suggest that

DEXMedetomidine is a superior adjuvant to Bupivacaine for SFIB, providing longer pain relief and reducing opioid dependence in lower limb surgeries.

Discussion

This study demonstrates that **DEXMedetomidine significantly prolongs analgesia duration and reduces opioid consumption** compared to **DEXAmethasone** when used as an adjuvant in SFIB.

Conclusion

This study concludes that **bupivacaine with DEXMedetomidine provides significantly longer postoperative analgesia and reduces opioid consumption compared to bupivacaine with DEXAmethasone in SFIB for lower limb surgeries**. Given its superior analgesic profile, **DEXMedetomidine may be the preferred adjuvant for SFIB**.

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