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An Observational Study to Compare the Effect of Intravenous Dexmedetomidine Versus Intravenous Magnesium Sulphate Pretreatment on Characteristics of Spinal Anaesthesia

Dr Vijayalaxmi Malhari[1], Dr Manjushree P Babladi[2], Dr Muktabai[3]

[1]Assistant Professor, Department of Anaesthesiology, Mahadevappa Rampure Medical College, Kalaburagi, India
[2]Assistant Professor, Department of Anaesthesiology, Mahadevappa Rampure Medical College, Kalaburagi, India
[3]Assistant Professor, Department of Anaesthesiology, Mahadevappa Rampure Medical College, Kalaburagi, India

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Corresponding Author:

Dr Muktabai
Assistant Professor, Department of Anaesthesiology, Mahadevappa Rampure Medical College, Kalaburagi, India
Email:
muktamath1509@gmail.com

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ABSTRACT

Background: Spinal anaesthesia is one of the most commonly employed regional anaesthetic techniques for infraumbilical surgeries due to its simplicity, rapid onset, and excellent sensory and motor blockade. However, its relatively short duration of action and limited postoperative analgesia remain important drawbacks. Various adjuvants have been investigated to enhance the quality and duration of spinal anaesthesia without increasing the dose of intrathecal local anaesthetic. Intravenous dexmedetomidine, a highly selective α2-adrenoceptor agonist, and intravenous magnesium sulphate, an N-methyl-D-aspartate (NMDA) receptor antagonist, have emerged as promising systemic adjuvants capable of prolonging neuraxial blockade and improving postoperative analgesia.

Objectives

1. To compare the onset and duration of sensory blockade between the two groups.
2. To compare onset and duration of motor block between the two groups.

Materials and Methods: A prospective observational comparative study was conducted among 60 adult patients (ASA physical status I–II) undergoing elective infraumbilical surgeries under spinal anaesthesia. Patients were allocated into two groups: Group A received intravenous dexmedetomidine (0.5 µg/kg over 10 minutes) and Group B received intravenous magnesium sulphate (30 mg/kg over 10 minutes) 20 minutes before administration of spinal anaesthesia.

Results: Patients receiving intravenous dexmedetomidine demonstrated a significantly faster onset of sensory (62.87±26.13 seconds) and motor blockade (3.63±0.49), prolonged duration of sensory (232.47±30.16 minutes) and motor block (246.87±26.25 minutes) when compared to magnesium group. There was also delayed requirement for rescue analgesia, and lower postoperative pain scores in dexmedetomidine group when compared with the magnesium sulphate group. Although mild bradycardia and sedation were more common with dexmedetomidine, haemodynamic variables remained clinically acceptable in both groups.

Conclusion: Intravenous dexmedetomidine pretreatment provides superior enhancement of spinal anaesthesia compared with intravenous magnesium sulphate by prolonging sensory and motor blockade, improving postoperative analgesia, and reducing analgesic requirements without significant adverse effects.

Keywords: *Dexmedetomidine, Magnesium sulphate, Spinal anaesthesia, Intravenous adjuvant, Postoperative analgesia, Infraumbilical surgery.*

INTRODUCTION

Spinal anaesthesia is widely preferred for lower abdominal, pelvic, perineal, and lower limb surgeries because it offers excellent surgical anaesthesia with minimal airway manipulation, reduced blood loss, lower incidence of thromboembolic events, and effective postoperative analgesia[1]. Despite these advantages, the relatively limited duration of spinal block often necessitates early postoperative analgesic supplementation.

Bupivacaine, an amino amide group of local anaesthesia is most widely used drug for spinal anaesthesia currently. Diverse classes of drugs such as opioids, epinephrine, neostigmine, magnesium, midazolam, ketamine, and clonidine have been added to intrathecal local anaesthetics in an attempt to prolong analgesia and reduce the incidence of adverse events[2].

Systemic pharmacological agents capable of enhancing neuraxial blockade without increasing intrathecal drug dosage have gained considerable interest[3]. Intravenous dexmedetomidine is a selective α2-adrenoceptor agonist with sedative, anxiolytic, sympatholytic, and analgesic properties[4]. Dexmedetomidine suppresses the activity in the descending noradrenergic pathway which modulates nociceptive neurotransmission, terminates propagation of pain signals leading to analgesia. The hypnotic and supraspinal analgesic effects are mediated by the hyperpolarization of noradrenergic neurons, which suppresses neuronal firing in the locus coeruleus along with inhibition of norepinephrine release and activity in the descending medullospinal noradrenergic pathway, secondary to activation of central alpha-2 adrenergic receptors. This suppression of inhibitory control triggers neurotransmitters that decrease histamine secretion producing hypnosis similar to normal sleep, without ventilatory depression, making dexmedetomidine a near ideal sedative.[5]

Magnesium sulphate possesses analgesic properties through antagonism of NMDA receptors and inhibition of calcium influx into neurons, reducing central sensitization and postoperative pain. Intravenous administration has also been reported to prolong spinal anaesthesia and decrease perioperative analgesic consumption.

The present study is being undertaken to evaluate the onset time of sensory and motor blockade, sedation, duration and analgesic efficacy of intravenous dexmedetomidine and intravenous magnesium sulphate used as adjuvants to 0.5% hyperbaric bupivacaine in spinal anaesthesia in patients undergoing infraumbilical surgeries.

OBJECTIVES

1. To compare the onset and duration of sensory blockade between the two groups.
2. To compare onset and duration of motor blockade between the two groups..

MATERIALS AND METHODS

Study Design

Prospective observational comparative study.

Study Setting

Department of Anaesthesiology, Basaveshwara teaching and general hospital, Kalaburagi.

Study Duration: 12 months.

Sample Size

60 patients.
Group A (Dexmedetomidine): 30 patients
Group B (Magnesium sulphate): 30 patients

Inclusion Criteria

1. Age 18–60 years.
2. ASA Physical Status I–II.
3. Elective infraumbilical surgeries under spinal anaesthesia.

Exclusion Criteria

1. Allergy to study drugs.
2. Pregnancy.
3. Cardiac conduction abnormalities.
4. History of bleeding diathesis.
5. Infection at the site of spinal needle insertion.
6. Neurological disorders
7. On treatment with alpha adrenoreceptor antagonists

METHODOLOGY

After the enrolment, demographic data such as age and sex was recorded. Preanaesthetic evaluation, general physical examination and systemic examination was carried out. Routine investigations such as haemogram, blood group, bleeding time, clotting time, prothrombin time, activated partial thromboplastin time, International Normalized Ratio (if the patient is on anticoagulant therapy), electrocardiogram, chest X-ray if required was done.

After standard monitoring (ECG, non-invasive blood pressure, and pulse oximetry) and intravenous access, patients received preload with crystalloid solution according to institutional protocol. Patients will be randomly allocated into one of the two groups by computer generated randomization.

Group A

Intravenous dexmedetomidine 0.5 µg/kg diluted in 100 mL normal saline administered over 10 minutes and 20 minutes before spinal anaesthesia.

Group B

Intravenous magnesium sulphate 30 mg/kg diluted in 100 mL normal saline administered over 10minutes and 20 minutes before spinal anaesthesia.

Following pretreatment, spinal anaesthesia was performed at the L3–L4 or L4–L5 interspace using a 25GQuincke spinal needle. Hyperbaric 0.5% bupivacaine (3 mL) was injected intrathecally.

Haemodynamic parameters: Intraoperatively HR, BP and SpO2 was measured and noted. The vitals will be monitored every 5 minutes for the first 30 min and later every 10 min.

Hypotension is defined as a decrease in systolic blood pressure by 20% from baseline, or a systolic blood pressure lower than 90 mm Hg and was treated with incremental doses of intravenous mephentermine (6 mg) and a bolus administration of 250 ml lactated Ringer's solution.

Bradycardia is defined as HR < 50 beats/min, and was treated with 0.6 mg of intravenous atropine.

Onset of sensory block was considered when there was loss of alcohol swab sensation noted at T10.

Onset of motor blockade: Using Modified Bromage Scale

- Bromage 0: Patient is able to move the hip, knee and ankle.
- Bromage 1: Patient is unable to move the hip, but is able to move the knee and ankle.
- Bromage 2: Patient is unable to move the hip and knee, but is able to move the ankle.
- Bromage 3: Patient is unable to move the hip, knee and ankle.

Onset of Motor block is considered when the patient is unable to move the hip, knee and ankle (Bromage 3).

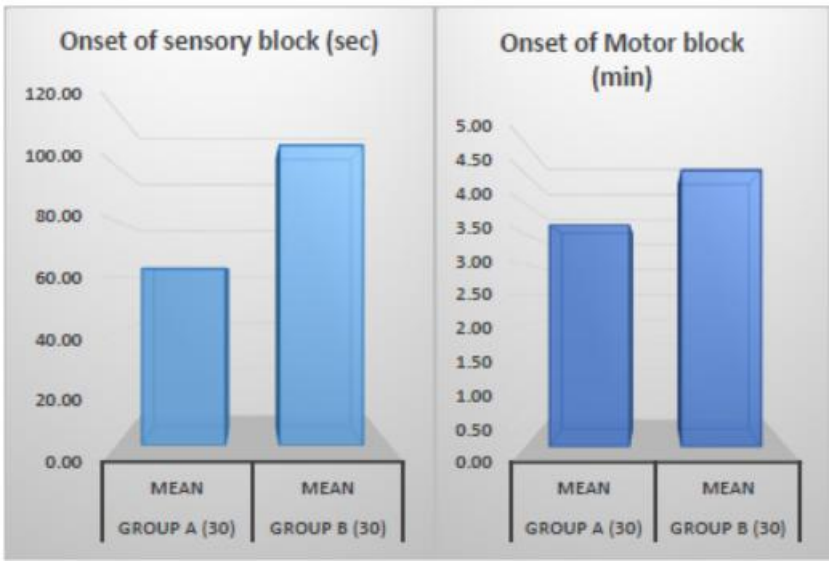
STATISTICAL ANALYSIS

Data was analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation. Independent Student's t-test was used for comparison of continuous variables, while categorical variables were analyzed using the Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant. Incidence of hypotension, bradycardia, nausea, vomiting, shivering and respiratory depression were also noted.

RESULTS

1. **Time of onset of sensory block (Time taken to reach T10 level)**
2. **Time of onset of motor block (Time taken to achieve Bromage 3)**

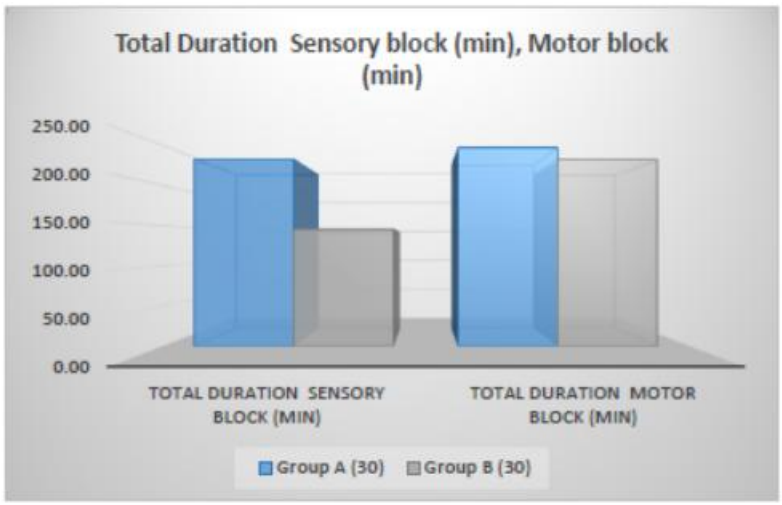
Parameters	Group A (n=30)		Group B (n=30)		p-value
	Mean	SD	Mean	SD	
Onset of sensory block (sec)	62.87	26.13	106.93	60.18	0.00
Onset of Motor block (min)	3.63	0.49	4.53	0.51	0.00



In the present study, time of onset of sensory blockade and motor blockade in dexmedetomidine group is 62.87±26.13 seconds and 3.63±0.49 minutes compared to 106.93±60.18 seconds and 4.53±0.51 minutes in group B which is statistically significant as the p value obtained is 0.00 and 0.00 for sensory and motor blockade.

Total duration of sensory block (seconds) and total duration motor block (seconds)

Parameters	Group A (n=30)		Group B (n=30)		p-value
	Mean	SD	Mean	SD	
Total duration of sensory block (min)	232.47	30.16	145.50	16.55	0.00
Total duration of motor block (min)	246.87	26.25	231.70	20.57	0.02



In our study, the average total duration of sensory blockade in dexmedetomidine group is 232.47±30.16 minutes compared to 145.50±16.55 minutes in group B, the p value obtained in our study is 0.00 which is statistically highly significant.

In the present study, the average total duration of motor block in dexmedetomidine group is 246.87±26.25 minutes, compared to 231.70±20.57 minutes in the group B, and the P value obtained in our study is 0.02 which is statistically significant.

DISCUSSION

Time of Onset of sensory and motor blockade

The present observational study demonstrated that intravenous dexmedetomidine pretreatment significantly enhanced the quality of spinal anaesthesia compared with intravenous magnesium sulphate.

Dexmedetomidine shortened the onset of sensory and motor blockade while significantly prolonging the duration of spinal anaesthesia and postoperative analgesia. Studies conducted by, Harsoor et al[6], Dinesh et al[7], Kaya F. N. et al[8] showed that dexmedetomidine shortened the onset time by 30 to 60 sec which is comparable to the present study. These effects are attributable to activation of α2-adrenoceptors within the locus coeruleus and dorsal horn of the spinal cord, producing analgesia through inhibition of norepinephrine release and suppression of nociceptive transmission.[9]

In the present study time of onset of sensory blockade and motor blockade in dexmedetomidine group is 62.87±26.13 seconds and 3.63±0.49 minutes compared to 106.93±60.18 seconds and 4.53±0.51 minutes in group B which is statistically significant as the p value obtained is 0.00 and 0.00 for sensory and motor blockade. The results of the present study is in concurrence with study conducted by Reddy et al.[10]

Total Duration of sensory and motor block

In our study, the average total duration of sensory blockade in dexmedetomidine group is 232.47±30.16 minutes compared to 145.50±16.55 minutes in group B, the p value obtained in our study is 0.00 which is statistically highly significant. Previous studies, conducted by Upadhyay et al[11], Lee et al[12], Gupta et al[13] shows a significant prolongation in the duration of sensory blockade.

A study by Jorm CM et al[14] found that Dexmedetomidine has an inhibitory effect on the locus coeruleus (A6 group) located at the brain stem. This supraspinal action could explain the prolongation of spinal anaesthesia after intravenous administration of Dexmedetomidine. Although mild bradycardia and sedation occurred more frequently, these adverse effects were clinically manageable and did not necessitate discontinuation oftherapy.[15]

Magnesium sulphate also prolonged sensory blockade and postoperative analgesia but to a lesser extent. Its analgesic effects result primarily from NMDA receptor antagonism, attenuation of central sensitization, and modulation of calcium-mediated neurotransmitter release.[16,17]

LIMITATIONS

- Single-centre observational study.
- Relatively small sample size.
- Lack of blinding.
- Serum magnesium concentrations were not measured.
- Long-term postoperative outcomes were not evaluated.

CONCLUSION

Intravenous dexmedetomidine pretreatment is more effective than intravenous magnesium sulphate in enhancing the characteristics of spinal anaesthesia. It provides faster onset, prolonged sensory and motor blockade, superior postoperative analgesia, and decreased rescue analgesic requirements.

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