The Effect of Dexmedetomidine Dosage on Duration of Spinal Anaesthesia using Hyperbaric Bupivacaine for Abdominal and Lower Extremity Surgeries

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Abstract

Spinal anaesthesia is commonly used for abdominal and lower limb surgeries. Dexmedetomidine, a new highly selective α2 agonist drug, is now being evaluated as a potential neuraxial adjuvant. This study has been designed to evaluate the addition of two doses of dexmedetomidine (10μg and 15μg) to 0.5% hyperbaric bupivacaine 3ml intrathecally for elective abdominal and lower limb surgeries. In a simple randomized study, 90 patients aged between 18-60 years of ASA I and II were randomized into three groups i.e., group I, II and III (n=30). All patients received a drug volume of 3.5 ml containing 3 ml hyperbaric bupivacaine (15 mg). They received dexmedetomidine 10μg (Group II) or 15μg (Group III) diluted to 0.5ml with 0.9% saline added to bupivacaine in the same syringe; the control group (Group I) received 0.5ml of 0.9% saline added to bupivacaine. It was found that the onset of sensory block up to T10 and motor block is statistically significantly faster in group II (155.17 sec and 203.83 sec) and III (99.37 sec and 170.13 sec) over group I (263.16 sec and 337.50 sec) in a dose dependent manner. The mean time for two segment regression, the mean time to sensory regression to S1, the mean duration of analgesia and the mean duration of motor blockade is significantly prolonged in Group III (141.67 min, 447.83 min, 400.67 min, 475.17 min) over Group II (106.17 min, 332.83 min, 287.67 min, 346.50 min) and Group II over Group I (97.33 min, 276.67 min, 243.17 min, 276.83 min) in a dose dependent manner (p<0.001). The data reveal that 15 μg of dexmedetomidine added to local anaesthetic in subarachnoid block to be a better adjuvant in prolonging the sensory and motor blockade intraoperatively and the duration of postoperative analgesia compared to 10 μg, without significant adverse effects. It is an attractive option for prolonged surgeries of the lower limb precluding the need for use of general anaesthetics and epidural anaesthesia.

Keywords: Alpha 2 Agonist, Dexmedetomidine, Hyperbaric Bupivacaine, Intrathecal Adjuvant, Spinal anaesthesia

Introduction

Spinal anaesthesia is used extensively for lower abdominal and lower extremity surgeries as it has distinct advantages over general anaesthesia. There is minimum physiological disturbance resulting in minimum stress response. It provides optimal operative conditions, minimal intraoperative blood loss and less postoperative morbidity.

Lignocaine and bupivacaine are the commonly used local anaesthetic agents for spinal anaesthesia. Lignocaine produce good motor blockade but duration of action is shorter and is associated with transient neurological complications whereas bupivacaine has been found to have less effective motor blockage but a slower onset of action.[1,2].

Neuraxial adjuvants are used to improve or prolong analgesia and decrease the adverse effects associated with high doses of a single local anaesthetic agent. In addition to their dose sparing effects, neuraxial adjuvants are also utilised to increase the speed of onset of neural blockade (reduce latency), improve the quality and prolong the duration of neural blockade. Neuraxial adjuvants include opioids, sodium bicarbonate (NaHCO3), vasoconstrictors, alpha-2 adrenoceptor agonists, cholinergic agonists, N-methyl-D-aspartate (NMDA) antagonists and γ-aminobutyric acid (GABA) receptor agonists.[3]

Dexmedetomidine is a more selective α2- adrenoceptor agonist that has been recently evaluated as an adjuvant to intrathecal local anaesthesia.[4-6]
Aims and Objectives

This study was undertaken with an aim to investigate and compare the effect of intrathecal administration of dexmedetomidine as adjuvant to 3ml 0.5% hyperbaric bupivacaine in doses of 10μg and 15μg intrathecally in groups II and III respectively versus the control group (group I).

The following parameters were evaluated in all the three groups -
- Time to onset of sensory and motor block
- Duration of sensory and motor blockade
- Duration of post-operative analgesia
- Side effects

Materials and Methods

This study was conducted at the K.B.N. Teaching & General Hospital, Kalaburagi attached to K.B.N. Institute of Medical Sciences, Kalaburagi. This study was done after Ethical Committee approval and written informed consent was obtained from all patients included in the study.

Study Design: This study was conducted in a simple randomized manner.

Inclusion criteria
- Age group 18-60 years
- ASA grade I and grade II
- Elective abdominal and lower limb surgeries

Exclusion criteria
- Patients belonging to ASA grade III, IV and V
- Patient refusal
- Liver and renal dysfunction
- Patients with cardiac dysrrhythmias
- Patients using adrenergic receptor blockers and / or calcium channel blockers
- Weight >120 kg or height < 150 cm
- Patients with contraindications for spinal anaesthesia
- Allergy to drugs

Selection of Cases: 90 patients were randomly divided into 3-groups.
- Patients in group I received 3.0 ml of 0.5% hyperbaric bupivacaine plus 0.5ml saline.
- Patients in group II received 3.0 ml of hyperbaric bupivacaine with 15 μg of Dexmedetomidine in 0.5ml saline.
- Patients in group III received 3.0 ml of hyperbaric bupivacaine with 15 μg Dexmedetomidine in 0.5ml saline

Pre-Anaesthetic Evaluation: Patients included in the study underwent thorough preoperative evaluation which included the following:

History: History of underlying medical illness, previous surgery, anaesthesia, allergy to the drugs under study and hospitalization were noted. Eligible patients were advised overnight starvation.

Physical examination included general condition of the patient, vital signs, height and weight, examination of CVS, RS, CNS and vertebral column, and Airway assessment.

Investigations: Hb, PCV, TLC, DLC, Platelet count, BT, CT, LFT, RFT, random blood sugar, ECG, CXR (PA), Blood grouping and cross matching were done. Patients who satisfied the inclusion criteria were explained about the nature of the study and the anaesthetic procedure. Written informed consent was obtained from all patients included in the study.

Technique: In the O.T., appropriate equipment for airway management and emergency drugs were kept ready. The horizontal position of the operating table was checked and patient shifted to the table. 18G i.v. cannula was inserted and the patient was preloaded with 500ml of Lactated Ringer's solution. NIBP, SpO₂, ECG leads were connected to the patient. Preoperative baseline systolic and diastolic BP, PR, SpO₂ and RR were recorded. Under strict aseptic precautions, a midline lumbar puncture was performed using a 25G Quincke needle in sitting position. The patient was then immediately placed in supine position. The time for intrathecal injection was considered as 0 and the following parameters were observed – sensory blockade, motor blockade, duration of analgesia and sedation.

Vital signs and side effects: The PR, systolic and diastolic BP, SpO₂ and RR were recorded every 2 min for 10 min and then every 5 min throughout the intraoperative period. The above vital signs at the completion of surgery were noted.

Assessment of Blockade after Spinal Anaesthesia

Sensory Block: Following subarachnoid block, sensory block was assessed by loss of sensation to pinprick using short hypodermic needle. The assessment was started...
immediately after injection and continued every 15 sec till loss of pinprick sensation at T_{10} level. Onset of sensory block was taken as time from intrathecal injection to loss of pinprick sensation at T_{10}. At 20 mins interval after SAB, the dermatomal level of sensory block was noted and it was considered as maximum level of sensory block.

**Motor Block:** Motor block was assessed using the modified Bromage score⁷.

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

Assessment of motor block was started immediately after the intrathecal injection. It was tested every 15 sec till Bromage Score of 3 was reached. Onset of motor block was taken as time taken to achieve Bromage score of 3 from subarachnoid block. The degree of motor block after 20 min of injection was noted and this was considered the maximum degree of motor block. Thereafter, motor block regression was noted and duration of motor block was taken as time from initiation of SAB to return of Bromage Score to 0.

**Sedation:** Sedation was assessed using the Ramsay sedation score

**Pain and Duration of Analgesia**

At the end of surgery, the degree of pain was assessed using VAS scale till VAS score ≥4 was reached. Whenever the patient complained of pain, the rescue analgesic, injection Diclofenac 75mg i.m. was given. Duration of effective analgesia was defined as time interval between onset of SAB and the time to reach VAS ≥4.

### Observation and Results

#### Statistical Analysis

All recorded data were entered using MS Excel software and analysed using SPSS 18 version software for determining the statistical significance. Analysis of Variance and z-test were used to study the significance of mean of various study parameters between the three groups. Chi-square test was used to study the significant association between sex distributions among the groups. The p-value taken for significance was less than 0.05. A p-value <0.001 was considered to be highly significant. The median was used to compute the maximum sensory and motor block and the sedation scores.

There was no statistical difference in patient demographics or duration of surgery and in all the 3-groups with respect to intraoperative and post-operative mean heart rate and mean arterial pressure (p>0.05).

The median of the maximum level of sensory block reached in all the three groups was T6 and motor block achieved was grade-3. There was no statistical significance.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group-I</th>
<th>Group-II</th>
<th>Group-III</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>37.45±14.77</td>
<td>36.90±15.07</td>
<td>39.00±15.96</td>
<td>0.859</td>
<td></td>
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<td>Sex ratio (male:female)</td>
<td>12:18</td>
<td>13:17</td>
<td>11:19</td>
<td>0.870</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161.93±8.02</td>
<td>160.93±10.55</td>
<td>162.13±6.35</td>
<td>0.842</td>
<td></td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>64.20±9.21</td>
<td>62.27±7.22</td>
<td>62.10±8.58</td>
<td>0.561</td>
<td></td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>98.00±35.68</td>
<td>99.67±37.41</td>
<td>114.67±33.50</td>
<td>0.142</td>
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</table>

Data presented is in mean±SD

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group-I</th>
<th>Group-II</th>
<th>Group-III</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of sensory block</td>
<td>263.16±115.05</td>
<td>155.17±81.19</td>
<td>99.37±33.88</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Onset of motor block</td>
<td>331.50±101.928</td>
<td>203.83±93.021</td>
<td>170.13±41.23</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Time to sensory regression to S_{1}</td>
<td>276.67±67.58</td>
<td>332.83±65.18</td>
<td>447.83±61.04</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Duration of analgesia</td>
<td>243.17±75.45</td>
<td>287.67±71.24</td>
<td>400.67±109.62</td>
<td>0.000</td>
<td>Significant</td>
</tr>
<tr>
<td>Duration of motor block</td>
<td>276.83±66.84</td>
<td>346.50±74.99</td>
<td>475.17±78.12</td>
<td>0.000</td>
<td>Significant</td>
</tr>
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</table>

Data presented is in mean±SD
**Table 3. Sedation scores**

<table>
<thead>
<tr>
<th>Maximum grade</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>30</td>
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</table>

**Discussion**

Dexmedetomidine a second generation α2 receptor specific, pharmacologically active d- isomer of medetomidine was first synthesized in the late 1980s.\(^{[12]}\)

Intrathecal dexmedetomidine when combined with spinal bupivacaine prolongs the sensory block by depressing the release of C fibres transmitters and by hyperpolarization of post synaptic dorsal horn neurons.\(^{[16]}\) Motor block prolongation by α2 adrenoceptors agonists may result from binding these agonists to motor neurons in the dorsal horn of the spinal cord.\(^{[17,18]}\) Intrathecal α2 receptor agonists have been found to have antinociceptive action for both somatic and visceral pain.

This study shows significant prolongation of the duration of spinal blockade by intrathecal administration of dexmedetomidine as an adjunct to hyperbaric bupivacaine for patients undergoing abdominal and lower extremity surgeries and is dose dependent.

In our present studies the mean onset of sensory block upto T10 is statistically significantly faster in group II and III over group I in a dose dependent manner. This correlates with the study by Al-Mustafa et al.,\(^{[6]}\) who found that the mean time of sensory block to reach T 10 was 4.7 ± 2 in D10group(dexmed 10mcg), 6.3 ± 2.7 min in D5(dexmed 5mcg)and 9.5 ± 3 min in group N.

The mean time to onset of Bromage 3 motor block is 337.50sec in group I, 203.83 sec in group II and 170.13 sec in group III. There is statistically significant difference among the three groups (p < 0.001) in a dose dependent manner. This correlates with the study by Al-Mustafa et al.,\(^{[6]}\) who found that the mean time to reach Bromage 3 scale was 10.4 ± 3.4 min with 10 mcg dexmedetomidine, 13 ± 3.4 min with 5mcg dexmedetomidine and 18 ± 3.3 min in control group.

In our study, there is significant difference between the groups in total duration of analgesia with group II having a much longer duration compared to group II which is longer than group I (p<0.001).

The median of the maximum motor block attained is Bromage grade 3 in all the 3 groups. Therefore, there is no statistical difference between the groups in this regard.

The mean duration of the motor block in group I, II, and III are 276.83 min, 346.50 min and 475.15 min respectively (p<0.001). Thus, there is a dose related prolongation of the duration of motor block.

In our study, there is no significant difference between all the 3 groups with respect to intraoperative and postoperative mean heart rates with p>0.05. All the 3 groups have similar mean SBP, DBP and MAP values throughout the intraoperative and postoperative periods with p>0.05.

Intrathecal dexmed did not potentiate the effect of bupivacaine on blood pressure. Local anesthetics reduce blood pressure by decreasing sympathatetic outflow.

In our studies the mean Ramsay sedation score in all the three groups is 2. Therefore, there is no significant difference between groups II and groups III. alpha agonists produce sedative effect by acting on α2 adrenergic receptors in locus ceruleus. The cause of sedation after intrathecal dexmed may be related to its systemic absorption and vascular redistribution to higher centres or cephalad migration in CSF.

The incidence of hypotension and use of vasopressor was higher in group II and group III (30%) and in group I (15%). The incidence of bradycardia and thus the use of atropine was higher in group II and group III. These differences were found to be stastically insignificant. Three patients each in group I and group III and one in group II had shivering, which was managed with i.v. tramadol 25 mg.

**Conclusion**

Dexmedetomidine, used as adjuvant in subarachnoid block, is associated with–

- Faster onset of sensory and motor block
- Prolonged duration of sensory and motor block
- Desirable sedation score and anxiolysis
- Lesser post operative analgesic requirement
- Stable haemodynamics and
- Insignificant adverse effects.

It can be concluded that 15 μg of dexmedetomidine
hydrochloride added to local anaesthetic in subarachnoid block has proved to be a better adjuvant in prolonging the sensory and motor blockade intra-operatively and duration of effective post-operative analgesia compared to 10 μg, without significant adverse effects. It serves as an attractive option for prolonged surgeries of the lower limb precluding the use of general anaesthetics and epidural anaesthesia.

References