



Effect of addition of dexmedetomidine or dexamethasone to bupivacaine for spinal anaesthesia for lower limb surgeries

Thesis

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَقُلْ اَعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ
وَرَسُولُهُ وَالْمُؤْمِنُونَ

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List of Abbreviations

| | |
|------------------|---|
| α 2AR | : Alpha 2 adrenergic receptor |
| ASA | : American society of anesthesiologists |
| C1-7 | : Cervical vertebrae 1-7 |
| CNS | : Central nervous system |
| CSF | : Cerebrospinal fluid |
| DBP | : Diastolic blood pressure |
| ECG | : Electrocardiogram |
| HR | : Heart rate |
| INR | : International normalized ratio |
| IV | : Intravenous |
| L1-5 | : Lumbar vertebrae 1-5 |
| MABP | : Mean arterial blood pressure |
| NIBP | : Non invasive blood pressure |
| NRS | : Numeric rating scale |
| NSAID | : Non steroidal anti-inflammatory drugs |
| PACU | : Postanaesthesia care unit |
| PT | : Prothrombin time |
| PTT | : Partial thromboplastin time |
| S1-5 | : Sacral vertebrae 1-5 |
| SBP | : Systolic blood pressure |
| SpO ₂ | : Oxygen saturation |
| t _{1/2} | : Half life |
| T1-12 | : Thoracic vertebrae 1-12 |

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Introduction

Lower limb surgeries are mostly performed under spinal anaesthesia. It has the advantage of being free from the risks of intubation but its duration of action is limited, so early analgesic intervention is needed in the postoperative period. Various intrathecal adjuvants to local anaesthetics have been found to improve the quality and extend duration of spinal block such as epinephrine, clonidine, opioids, etc. The addition of epinephrine to local anaesthesia causes tachycardia, and hypertension which can be risky in patients with cardiovascular disease. Intrathecal opioid administration has central and respiratory depression effects (**Brown, 2010**).

Dexmedetomidine is a highly selective α_2 -adrenergic agonist which has been used as pre-medication and as an adjuvant to general anaesthesia. It has several beneficial actions during perioperative period. It decreases sympathetic tone with attenuation of the neuroendocrine and haemodynamic response to anaesthesia and surgery, reduces anaesthetic and opioid requirements, causes sedation and analgesia. It was first introduced into clinical practice as a short term intravenous sedative in intensive care units (**Sunil et al., 2013**).

Intrathecal dexmedetomidine prolongs both sensory and motor block and has antinociceptive action for both visceral and somatic pain. It is used to enhance the analgesic property of local anaesthetics like lidocaine, bupivacaine and ropivacaine (**Sunil et al., 2013**).

Dexmedetomidine was first used intrathecally in humans for transurethral resection of prostate. It produced analgesia by depressing the release of nociceptive C fibers transmission and hyperpolarization of post synaptic dorsal horn cells (**Kanazi et al., 2006**). Also, It showed neuroprotective and growth effect on nerve cells and spinal cord cells similar to methylprednisolone in spinal cord injury when used intrathecally (**Celik et al., 2013**).

Intrathecal injection of steroids was frequently used for the treatment of meningitis, chronic lymphocytic leukemia and central nervous involvement in lupus erythematosus (**Dong et al., 2001**). Some works demonstrated that addition of dexamethasone to local anaesthetics prolonged duration of blockade of peripheral nerves. It relieves pain by reducing inflammation and blocking transmission of nociceptive C-fibers and by suppressing ectopic neural discharge (**Golwala et al., 2009**). Intrathecal dexamethasone is used to prolong duration of sensory block and postoperative analgesia in patients undergoing surgery, also it is used to control chronic pain (**Bani et al., 2011**).

Aim of the Work

The aim of this study is to compare the effect of addition of dexmedetomidine or dexamethasone to bupivacaine on the onset time and duration of spinal anaesthesia, quality of block, intraoperative and postoperative complications and postoperative analgesia in patients undergoing lower limb surgeries.

Spinal Anaesthesia

Spinal anaesthesia was performed for the first time by professor Bier at the Royal Surgical hospital at the University of Kiel, Germany, in 1898, showing the advent of major regional anaesthesia using neuro-axial blockade. It was also performed by Labat at the Mount Sinai Hospital in 1927 and since then spinal anaesthesia has been well incorporated into the practice of anaesthesia (*Larson, 1996*).

Physiological considerations:

The physiologic response to central block is determined by the effects of interrupting the afferent and efferent innervations of somatic and visceral structures. Somatic structures are traditionally related with sensory and motor innervations, while the visceral structures are more related to the autonomic nervous system.

A-Somatic blockade:

Prevention of pain and skeletal muscle relaxation are classic objectives of central blockade. Nerve fibers are not homogenous. There are three main types of nerve fibers designated A, B and C. The A group has four sub-groups alpha, beta, gamma and delta. The functions of the main groups and sub-groups are summarized in table (1). The minimum concentration of local anaesthetic required to stop transmission of impulses varies depending upon fiber size and presence of myelination. Small or myelinated nerves are more easily blocked than large or unmyelinated nerves (*Casey, 2000*).

There is large interindividual variability in nerve root size. These differences may help explain the inter-patient differences in neuraxial block quality when equivalent techniques are used on seemingly similar patients. Another anatomic relationship which may affect neuraxial blocks is that; although the dorsal (sensory) roots are generally larger than the anterior (motor) roots, the dorsal roots are often blocked more easily. This seeming paradox is explained by organization of the dorsal roots into component bundles, which creates a much larger surface area on which the local anaesthetics act, thus perhaps explaining why larger sensory nerves are blocked more easily than smaller motor nerves (*Liu and Mcdonald, 2001*).

Table (1): Nerve fibers classification

| Class | Action | Myelin | Size |
|-----------------------------|----------------------------------|---------------|-------------|
| Aα | Motor | Yes | ++++ |
| Aβ | Light touch, pressure pain | Yes | +++ |
| Aγ | Proprioception | Yes | +++ |
| Aδ | Pain, temperature | Yes | ++ |
| B | Preganglionic sympathetic fibers | Yes | ++ |
| C | Pain, pressure | No | + |

(*Kleinman and Mikhail, 2006*)

B-Visceral blockade:

Most of the visceral effects of central blockade are mediated by interruption of autonomic impulses to various organ systems.

1. Cardiovascular effect:

Sympathetic blockade results in cardiovascular changes of haemodynamic consequence in proportion to the degree of sympathectomy. The sympathetic chain originates from the lumbar and thoracic spinal cord. The fibers involved in smooth muscle tone of the arterial and venous circulation arise from T₅ and L₁. Arteries retain most of their tone despite sympathectomy because of local mediators and there is no arteriolar vasoplegia, but the venous circulation does not. The consequence of total sympathectomy is an increase in the volume of the capacitance vessels, especially in the splanchnic circulation, decreasing the venous return to the heart and hypotension occurs (*Butterworth, 1998*).

The cardiac accelerator fibers are sympathetic efferents, which increase heart rate when stimulated. When blocked by high central blockade, unopposed vagal action leads to bradycardia (*Brown, 2005*).

Prophylactic administration of pharmacologic agents may be more effective than prehydration to prevent hypotension. α -adrenergic agents, as phenylephrine, reliably increase arterial blood pressure by increasing systemic vascular resistance, however, heart rate and cardiac output may decrease because of increased after load (*Buggy et al.,*