Comparative Study between the Effects of Intravenous or Intrathecal Dexmedetomidine on Characteristics of Bupivacaine Spinal Block in Lower Limb Orthopedic Surgeries

Thesis

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Joseph Sobhy Yacoub Halaka

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List of Abbreviations

ANOVA	:	A one-way analysis of variance
cAMP	:	Cyclic adenosine monophosphate
CNS	:	Nervous system
CSF	:	Cerebrospinal fluid
F	:	ANOVA
FDA	:	Food and Drug Administration
GDP	:	Guanyl di-phosphate
GTP	:	Guanyl tri-phosphate
HR	:	Heart rate
ICU	:	Intensive care unit
LSD	:	Least Significant Difference
MAP	:	Mean blood pressure
Mg	:	Magnesium sulfate
PACU	:	Post Anesthesia Care Unit
PDPH	:	Post-dural puncture headache
x2	:	Chi-square test

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Comparative Study between the Effects of Intravenous or Intrathecal Dexmedetomidine on Characteristics of Bupivacaine Spinal Block in Lower Limb Orthopedic Surgeries

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ABSTRACT

Background: Lower limb orthopedic surgeries performed under spinal anesthesia have the advantage of having rapid onset, maintaining spontaneous breathing, relaxing the necessary muscles for surgery, and cost effectiveness. It also has the advantage of being free from the risks of intubation and pulmonary aspiration. **Aim of the Work:** This study was designed to compare between intrathecal versus intravenous dexmedetomidine when added to bupivacaine on spinal block characteristics in patients undergoing lower limb orthopedic surgery regarding, onset and duration of sensory and motor block, quality of intra-operative anesthesia, postoperative analgesia, level of sedation, and adverse effects on patient hemodynamics. **Patients and Methods:** Following approval of our departmental ethical committee and obtaining informed consent, sixty patients scheduled for lower limb orthopedic surgeries under spinal anesthesia were enrolled in this prospective randomized comparative study. **Results:** *********. **Conclusion:** Both intrathecal and intravenous dexmedetomidine were safe adjuvants to bupivacaine spinal anesthesia. Intrathecal dexmedetomidine is superior adjuvant to spinal bupivacaine when compared to intravenous dexmedetomidine. It provides more stable hemodynamics, greater augmentation to sensory and motor block, better quality of perioperative analgesia and lesser overall side effects. Intravenous dexmedetomidine provides higher level of sedation during the intra-operative period. Recommendations: Further studies on a larger scale of patients are required to confirm the results obtained by this work.

Key words: dexmedetromidine, bupivacaine spinal block, lower limb, orthopedic surgeries

Introduction

Lower abdominal and lower limb surgeries may be performed under local, regional (spinal or epidural) or general anesthesia, but neuraxial blockade is the preferred mode of anesthesia. Spinal block is still the first choice because of its rapid onset, superior blockade, lower risk of infection as from catheter in situ, less failure rates and cost-effectiveness, but has the drawbacks of shorter duration of block and lack of postoperative analgesia ***(Shukla et al., 2011).***

Spinal anesthesia has the advantage of being able to maintain spontaneous breathing as well as relaxing the necessary muscles for surgery. It also has the advantage of being free from the risks of intubation and pulmonary aspiration ***(Shukla et al., 2011)***.

In recent years, use of intrathecal adjuvants has gained popularity with the aim of prolonging the duration of block, better success rate, patient satisfaction, decreased resource utilization compared with general anesthesia and faster recovery. Adequate pain management is essential to facilitate rehabilitation and accelerate functional recovery, enabling patients to return to their normal activity more quickly. The quality of the spinal anesthesia has been reported to be improved by the addition of opioids (such as morphine, fentanyl and sufentanil) and other drugs [such as dexmedetomidine (DXM), clonidine, magnesium sulfate (Mg), neostigmine, ketamine and midazolam], but no drug to inhibit nociception is without associated adverse effects ***(Chatrath et al., 2014).***

Bupivacaine is a drug with long lasting local anesthetic effect, in neuraxial anesthesia, provides an effective and safe anesthesia ***(Coskuner et al., 2007)***.

Recently, Alpha 2-adrenoceptor agonists are being increasingly used in anesthesia and critical care as they not only decrease sympathetic tone and attenuate the stress responses to anesthesia and surgery; but also cause sedation and analgesia; they are also used as adjuvants during regional anesthesia ***(Bajwa and Kulshrestha, 2013)***.

Dexmedetomidine is the most recent agent in this group approved by FDA in 1999 for use in human for analgesia and sedation ***(Kanazi et al., 2006)***.

Dexmedetomidine was studied as an intrathecal adjunct to bupivacaine spinal block in different surgical procedures. These studies showed that intrathecal addition of dexmedetomidine to bupivacaine produced shorter onset and longer duration of sensory, motor block, enhanced postoperative analgesia and sedation without serious side effects in different surgical procedures ***(Niu et al., 2013)***.

Many studies also examined the effect of intravenous Dexmedetomidine as an adjuvant to spinal block in a variety of surgical procedures. These studies showed that intravenous dexmedetomidine can prolong the duration of sensory and motor blocks as well as the time to first analgesic request of spinal anesthesia ***(Upadhyay et al., 2015)***.

Aim of the Work

This study was designed to compare between intrathecal versus intravenous dexmedetomidine when added to bupivacaine on spinal block characteristics in patients undergoing lower limb orthopedic surgery regarding, onset and duration of sensory and motor block, quality of intra-operative anesthesia and adverse effects on patient hemodynamics postoperative analgesia, level of sedation,.

Spinal Anesthesia

Introduction:

Of all regional anesthetic techniques, spinal anesthesia is the one most frequently used by anesthesiologists. Lumbar or subarachnoid anesthesia is other names for this nerve-blocking procedure performed close to the spine. Spinal anesthesia is distinguished by its ease of performance, rapid onset of action, excellent anesthetic efficacy and motor blockade. Additionally, it is free from systemic toxicity. Spinal anesthesia is especially suitable for all interventions in the lower and middle abdomen, for operations of the hip joint, lower extremities, prostate and bladder as well as of the peripheral vasculature. Increasingly, gynecological and obstetric procedures – especially cesarean sections – are performed under spinal anesthesia. Patients benefit from spinal anesthesia because it has little effect on physiological respiratory parameters, functional residual capacity, shunt volumes or respiratory drive. The rate of postoperative pneumonia or respiratory insufficiency is lower than after intubation anesthesia ***(Mulroy, 2009).***

ANATOMY:

The spinal canal has a protective sheath composed of three layers. From the outside to the inside they are: Dura mater, arachnoid and pia mater. The potential space between the dura and arachnoid is called subdural space.

The cerebrospinal fluid (CSF) flows between the arachnoid and pia mater in the space called subarachnoid space. The spinal cord begins cranially at the foramen magnum, as a continuation of the medulla oblongata. It terminates caudally at the conus medullaris, which in the adult corresponds to the level of the lower border of L1, and in the young child to the upper border of L3. From this end, a prolongation of the pia mater called the filum terminale attaches the spinal cord to the coccyx. The dural sac itself ends at the level of the second sacral vertebra ***(Snell, 2012).***

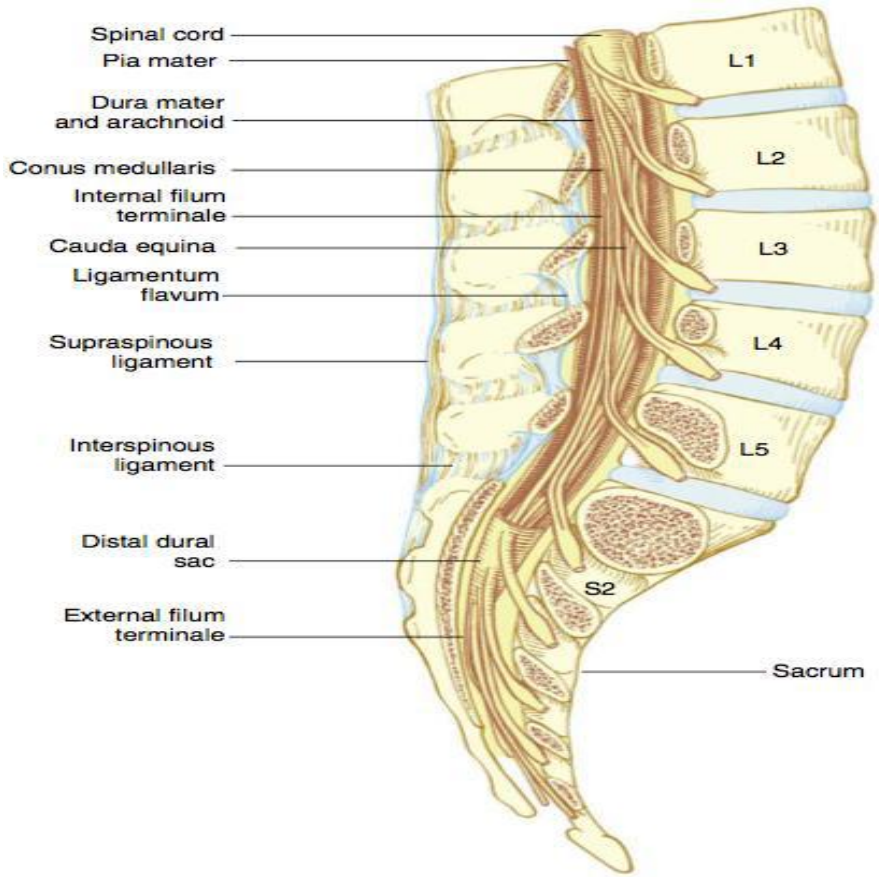

Fig. (1): Longitudinal section of spinal cord and covering meninges (www.profelis.org)

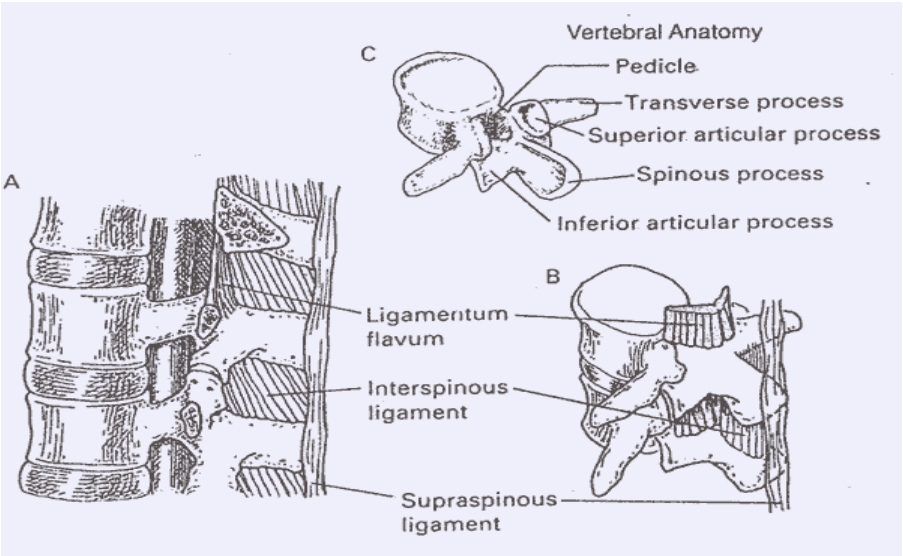

Fig. (2): Spinal ligaments, hold the spines together (Netter,2006)

The spinal cord is composed of a core of gray matter surrounded by white matter. The gray matter on cross section has an H shape, with ventral (motor) and dorsal (sensory) horns. The white matter is described as having anterior, lateral and posterior white columns. There are 31 pairs of spinal nerves; each one being formed by two roots, a ventral or motor root and a dorsal or sensory root. The dorsal root has the dorsal root ganglion. Because the spinal cord of an adult is shorter than the vertebral column, the spinal nerves descend a variable distance in the spinal canal before exiting through the intervertebral foramen. ***(Bernards, 2017).***

The most distal lumbar and sacral nerves travel the longest distance inside the spinal canal, forming what is known as the cauda equine. As the spinal nerve pierces the dural sac, it draws with it a dural sleeve. The spinal nerves

exit through the inter-vertebral foramen, formed between two vertebrae. There are 8 cervical nerves. The first cervical nerve exits through the occipital bone and C1, the 8th cervical nerve exits between C7 and T1. Distal to T1 each spinal nerve exits below the corresponding vertebra. The vertebral column has a series of curvatures in the anteroposterior plane. The cervical and lumbar curvatures have an anterior convexity (lordosis) and the thoracic and sacral have posterior convexity (kyphosis). These curvatures play a role in the spread of the local anesthetic solution ***(Bernards, 2017).***

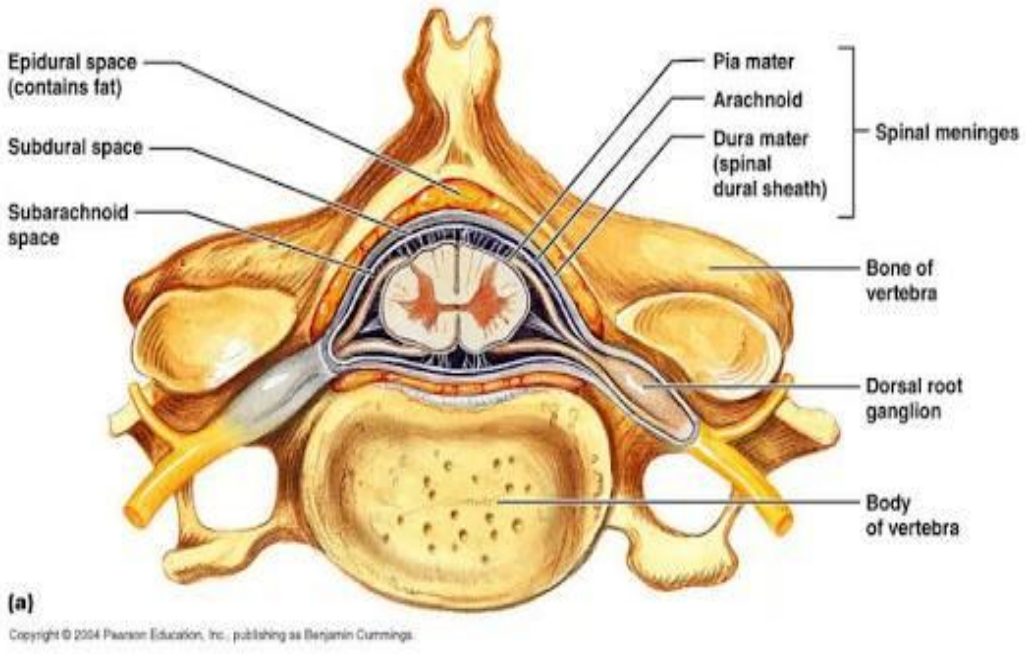

Fig. (3): Cross section of spinal cord within the vertebral canal (www.profelis.org)