



Epidural Bupivacaine-Dexmedetomidine versus Bupivacaine-Fentanyl for Anesthesia in Knee Surgeries

Thesis

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List of Abbreviations

Abb.	Full term
5 HT3	<i>Hydroxytryptamine (serotonin)</i>
ACL	<i>Anterior cruciate ligament</i>
ACLS	<i>Advanced cardiac life support</i>
ACTH	<i>Adrenocorticotrophic hormone</i>
ASA	<i>American Society of Anesthesiologists</i>
BB	<i>Beta blocker</i>
BID	<i>Twice a day</i>
BVs	<i>Blood vessels</i>
Ca++	<i>Calcium Ion</i>
Camp	<i>Cyclic adenosine monophosphate</i>
CNS	<i>Central nervous system</i>
CSF	<i>Cerebrospinal fluid</i>
CTZ	<i>The chemoreceptor trigger zone</i>
EEG	<i>Electroencephalogram</i>
GABA	<i>Gamma aminobutyric acid</i>
IV	<i>Intravenous</i>
K+	<i>Potassium ion</i>
LA	<i>Local anesthetics</i>
LAH+	<i>Ionized local anesthetics</i>
MRI	<i>Magnetic resonance imaging</i>
Na+	<i>Sodium ion</i>
NSAIDs	<i>Non-steroidal anti-inflammatory drugs</i>
VD	<i>Vasodilatation</i>
VLPO	<i>The ventrolateral preoptic nucleus</i>

INTRODUCTION

Surgical conditions primarily dictate the type of anesthesia performed; however, most operations below the neck region can be performed under neuraxial anesthesia.

Epidural anesthesia is the most commonly used technique for inducing surgical anesthesia and postoperative analgesia in lower limb surgeries, It has been shown to decrease pain, nausea, vomiting and time to discharge, as well as reducing incidence of deep vein thrombosis, pulmonary embolism, blood transfusion requirement and respiratory depression (*Rodgers et al., 2000*). But to achieve these effects, it requires large doses of bupivacaine (*Gupta et al., 2011*).

Many adjuvants are added to local anesthetics to improve the quality of epidural block and prolong blockade such as opioids, α -2 agonists, ketamine, magnesium, neostigmine, NSAIDs and neuromuscular blocking drugs (*Bauer et al., 2011*).

Opioids such as Fentanyl are commonly used as an adjuvant to bupivacaine to reduce the dose, fasten the onset and prolong the duration of anesthesia (*Rastogi et al., 2013*).

Fentanyl, an opioid analgesic is a lipid-soluble, μ -receptor agonist with a rapid onset and short duration of action. It has been commonly used as adjuvant to local anesthetics in epidural anesthesia in doses of 50 μ g to 100 μ g with minimal side effects. They hasten the onset, improve the quality of the block and prolong the duration of analgesia (*Parate et al., 2015*).

Dexmedetomidine which is selective α -2 adrenergic agonists with analgesic and anxiolytic properties, is a safe and effective adjuvant to many anesthetic techniques such as intrathecal or epidural anesthesia. It is being used as adjuvant to local anesthetics same as opioids (*Carollo et al., 2008*).

Its pharmacological actions are resulting from activation of α 2 adrenergic receptors, and depending on their location; their stimulation in the central nervous system (CNS) result in inhibition of calcium influx in the nerve terminals with subsequent inhibition of the neurotransmitter release thus facilitating analgesia (*Haselman., 2008*).

Epidural blocks with dexmedetomidine is found to exhibit synergism with local anesthetics and result in prolonged sensory and motor block and offers postoperative analgesia (*Eskandara et al., 2014*).

AIM OF THE WORK

The purpose of this study is to compare the efficacy of using fentanyl and dexmedetomidine with bupivacaine in epidural block for knee surgeries, the time of onset of sensory, motor blockade and the duration of this blockade.

Chapter One

THE EPIDURAL

A) EPIDURAL ANATOMY

The Epidural Space (Cavum Epidurale):

The epidural space (also referred to; as *the extradural and peridural space*) lies between the dura and the borders of the spinal canal. Anteriorly, this border is the posterior longitudinal ligament; posteriorly, it is the vertebral lamina and adjoining ligamentum flavum (**Figure 1a**) which is actually made of two separate ligament flava -the right and the left- have been reported by some authors to be fully joined in the midline, whereas others have found a mid-sagittal gap. The phenomenon of the unilateral epidural blockade occasionally occurs after epidural anesthesia and is a relatively frequent clinical observation (*Warren et al., 2008*).

The spinal epidural space runs from the level of the foramen magnum to the sacral hiatus, which is bound by the sacrococcygeal ligament. The lateral borders of the epidural space are partially delineated by the vertebral pedicles, but this space extends laterally through the intervertebral foramina to communicate with the paravertebral spaces on each side. The epidural space is somewhat compartmentalized by the sections of the dura abutting the ligamentum flavum, vertebral lamina,

and other borders of the vertebral canal (**Figure 1b**). However, these compartments are joined by a “potential space” that is opened by injection of fluid or air, thus connecting the compartments and revealing a more continuous communication (*Carpenter et al., 1992*)

There is negative pressure in the epidural space in some 80-90% of patients. However, the negative pressure is not the same at all levels and it varies according to intrathoracic respiratory pressure variations, as well as to posture. The negative pressure increases in the sitting position, while in the supine position it is reduced. It is also reduced in pulmonary diseases (emphysema, asthma) and during heavy coughing or straining (*Jankovic, 2004*).

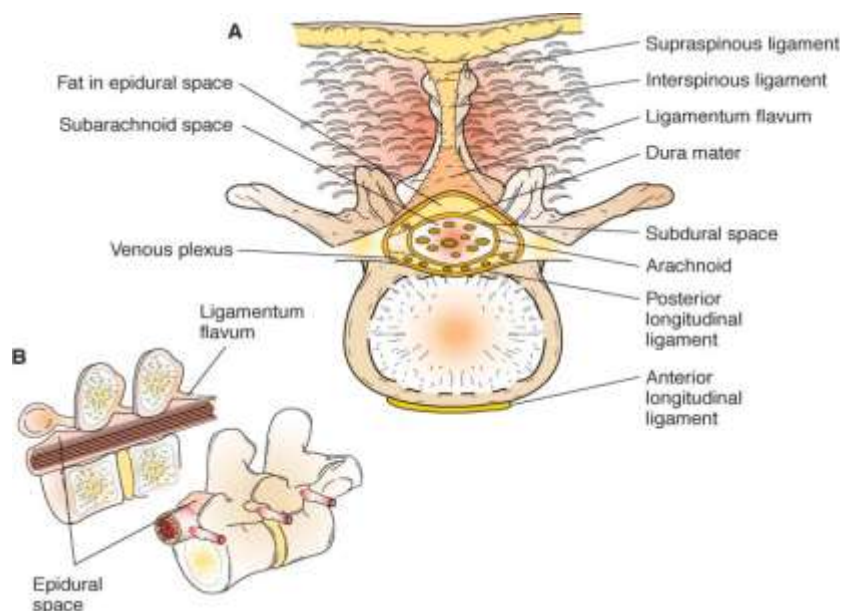


Figure (1): (a&b): Cross-sectional view of the lumbar region (*Warren et al., 2008*).

The epidural space is not a continuous space, but segmented along its length (**Figure 2**) (*Hogan, 1991*).

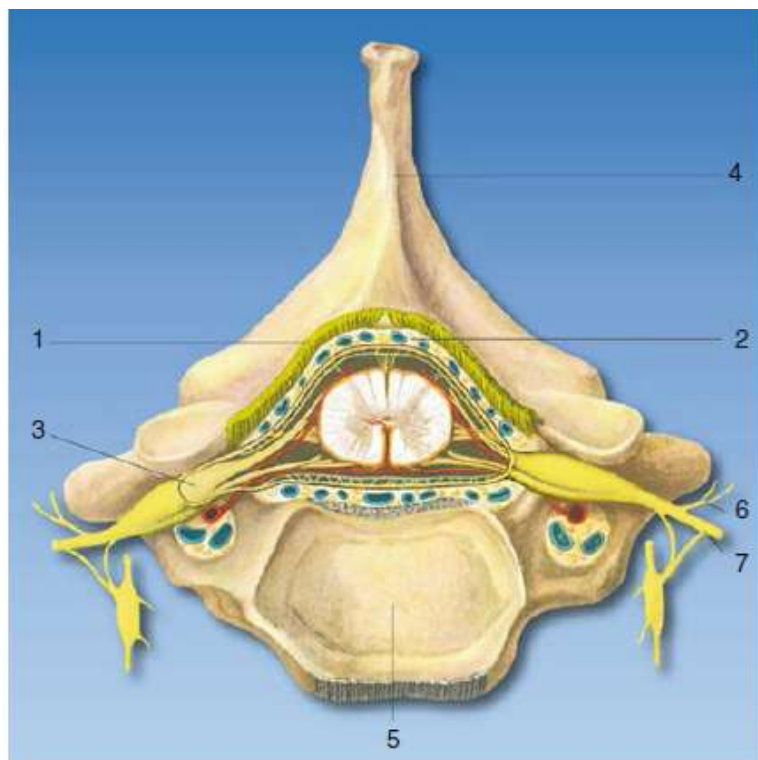


Figure (2): Cross section of the epidural space.

(1) Ligamentum flavum, (2) epidural space, (3) spinal ganglion, (4) spinous process, (5) body of vertebra, (6) dorsal branch of spinal nerve, and (7) ventral branch of spinal nerve (*Jankovic, 2004*).

The contents of the epidural space include epidural fat (semifluid), venous plexus, segmental arteries and lymphatics. The epidural fat is largely located in the posterior and lateral aspects of the epidural space. The valveless plexus of epidural veins (***Bateson plexus***) is principally within the anterior and lateral portions of the epidural space,

with rare presence in the posterior aspect. These veins communicate with the azygous system, and thus can become engorged in the setting of increased intra-abdominal pressure (*Backes et al., 2008*).

The epidural fat in the epidural space may play an important role in the pharmacokinetics of epidurally administered lipophilic drugs by acting as a reservoir. This may result in a delayed onset and a longer duration of action (*Reina et al., 2009*).

A reduction in the epidural fat with age may partly explain the age related changes in epidural dose requirements i.e., the elderly patient requires less local anesthetic than a younger patient to achieve a block at the same level (*Igarashi et al., 1997*).

The depth of the epidural space from the skin varies with *body weight*, being less in a thin individual and more in an obese or pregnant individual (*Ravi et al., 2011*).

Ultrasound is a useful tool for measuring this depth (*Balki et al., 2009*).

The epidural space is found variably 3–5 cm beneath the skin (range 2–7 cm). The distance from the posterior epidural space border to the dural sac varies from ~6 mm in the lumbar region to only 1 mm in the cervical region (*Erdmann, 2001*).

The caudal space is the sacral portion of the epidural space. Caudal anesthesia involves needle and/or catheter penetration of the sacrococcygeal ligament covering the sacral hiatus that is created by the unfused S₄ and S₅ laminae, the hiatus may be felt as a groove or notch above the coccyx and between two bony prominences, the sacral cornu. Its anatomy is more easily appreciated in infants and children. The posterior superior iliac spines and the sacral hiatus define an equilateral triangle. Calcification of the sacrococcygeal ligament may make caudal anaesthesia difficult or impossible in older adults. Within the sacral canal, the dural sac extends to the first sacral vertebra in adults and to about the third sacral vertebra in infants, making inadvertent intrathecal injection more common in infants (*Peutrell et al., 2003*).

B) Epidural Anesthesia

I- Physiological Effects of Neuraxial Block:

The physiological effects of both subarachnoid and an epidural block are quite similar. However, the effects of an epidural block have a slower onset and are usually segmental in nature, due to the segmental spread of local anesthetic in the epidural space.

A- Neurological Blockade:

The injection of local anesthetic within the intrathecal or epidural space produces nerve blockade. This blockade first affects the smaller diameter sympathetic fibers (T₁-L₂), before the larger myelinated sensory-motor fibers (*Jaffe et al., 1996*).

As a result, autonomic block manifests before sensory block, which in turn precedes the motor block. Among the sensory modalities, the sequence of blockade is temperature, pain, touch, pressure, and finally proprioception.

Block dissipation occurs in the reverse manner with autonomic fibers being the last to recover. In general, more dilute solutions affect the sensory fibers preferentially, while higher concentration is needed to block the motor fibers. Sensory block extends two to four segments higher than motor block, and the sympathetic block extends two to four