Comparative study between intrathecal dexmedetomidine and fentanyl as adjuvants to bupivacaine in total hip arthroplasty surgeries

Thesis

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List of Abbreviations

µg	Microgram
ACE	Angiotensin converting enzyme
AR	Adrenergic receptor
ASA	American society of anaesthesiologist
BP	Blood pressure
C	Control
CN	Central nervous.
CNS	Central nervous system.
CNS	Central nervous system
CPR	Cardio pulmonary resuscitation
CSF	Cerebro spinal fluid.
CV	Cardio vascular.
D	Dexmedetomidine
DBP	Diastolic blood pressure
F	Fentanyl
FDA	Food and drug administration
G	Gauge
Hr	Hour
HR	Heart rate
ICP	Intra cranial pressure
ICU	Intensive care unit
Io	Intraoperative
IV	Intravenous
Kg	Kilogram

List of Abbreviations

L	Liter
mg	Milligram
min	Minute
ml	Milliliter
mmHg	Millimeter mercury
MRI	Magnetic resonance imaging
NMDA	N-methyl-D-aspartate.
NRS	Numerical rating scale
PABA	Para amino benzoic acid.
PACU	Post anaesthesia care unit
Po	Postoperative
SBP	Systolic blood pressure
SD	Standard of deviation
TRI	Transient radicular irritation.

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Introduction

Total hip arthroplasty surgeries may be performed under local, regional or general anaesthesia, but neuraxial blockade is the preferred mode of anaesthesia. Spinal anaesthesia is still the first choice because of its rapid onset, superior blockade, low risk of infection as from catheter in situ, less failure rates and cost effectiveness. However, postoperative pain control is a major problem because spinal anaesthesia using only local anaesthetics is associated with relatively short duration of action, and so early analgesic intervention is needed in the postoperative period **(Aamir et al., 2015).**

The commonly used local anaesthetic lidocaine has neurotoxic effects and this has been largely replaced by other agents such as bupivacaine. The routine doses of bupivacaine are associated with prolonged and intense sensory and motor block and significant sympathetic block, which may not be desirable in some patients. Low dose diluted bupivacaine limits the distribution of spinal block and yield a comparably rapid recovery, but may not provide an adequate level of sensory block **(Hem et al., 2014).**

The 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 anaesthesia and faster recovery **(shukla et al., 2011).**

The potentiating effect of short acting lipophilic opioid as fentanyl and a more selective α2 agonist as dexmedetomidine is used to reduce the dose requirement of bupivacaine and its adverse effects. These spinal adjuncts are used not only to reduce side effects of local anaesthetics, but also to prolong analgesia **(Hem et al., 2014).**

Fentanyl is a lipophilic μ-receptor agonist. In spinal anaesthesia, fentanyl exerts its effect by combining with opioid receptors in the dorsal horn of spinal cord and may have a supraspinal spread and action **(Shukla et al., 2011).**

Dexmedetomidine, a highly selective α2 agonist drug, is approved as an intravenous sedative and co analgesic drug. Its use is often associated with a decrease in heart rate and blood pressure. Intrathecal α2 receptor agonists have antinociceptive action for both somatic and visceral pain. Dexmedetomidine shows more specificity towards α2 receptor ($\alpha2/\alpha_1$ 1600:1) compared with clonidine ($\alpha2/\alpha_1$ 200:1) **(Reves et al., 2010).**

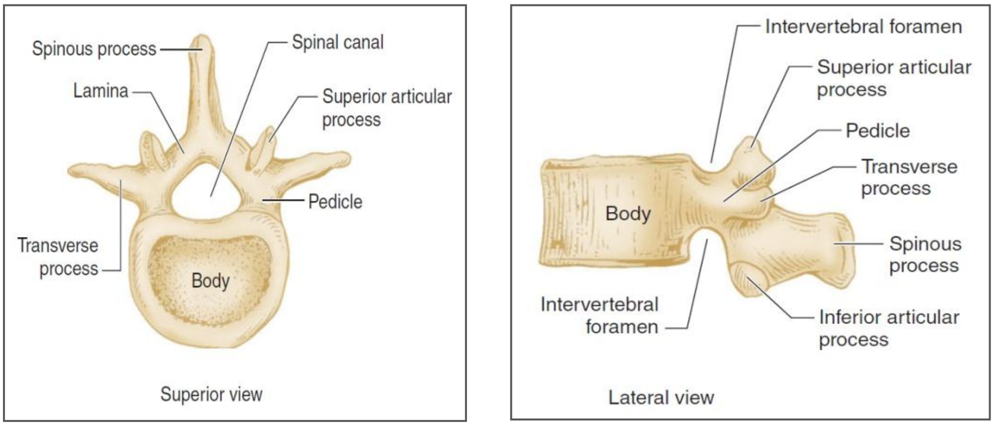
Aim of the work

The study aims to compare the effects of dexmedetomidine versus fentanyl given with hyperbaric 0.5% bupivacaine in subarachnoid anaesthesia on onset, duration of sensory and motor block, hemodynamic effects, postoperative analgesia, and adverse effects.

Anatomy of the spinal canal

The spinal cord and its nerve roots lie within the central bony canal of the vertebral column, which provides them with structural support and protection. The vertebral column is made up of seven cervical, twelve thoracic, five lumbar, five sacral, and four coccygeal vertebrae. Most vertebrae have similar features: a vertebral body, two pedicles, and two laminae. The spinal canal is bounded by the vertebral bodies anteriorly, the pedicles laterally, and posteriorly by lamina **(Figure 1).** Each has a midline spinous process that arises between the laminae and two transverse processes that arises laterally at the junction of the lamina and pedicle. These processes serve as attachments for muscles and ligaments. Each vertebra has four articular processes: two project upward and two project downward **(Figure 1).**

Articular processes serve as synovial joints between vertebrae. The joint formed between the articular processes of adjacent vertebrae is called the facet joint. Adjacent vertebral bodies are attached through fibrocartilaginous intervertebral discs**.** Pedicles have large notches on their inferior surface and smaller notches on their superior surface. Notches from adjacent vertebrae form intervertebral foramina that through which nerve roots exit the spinal column **(Morgan et al., 2013)**



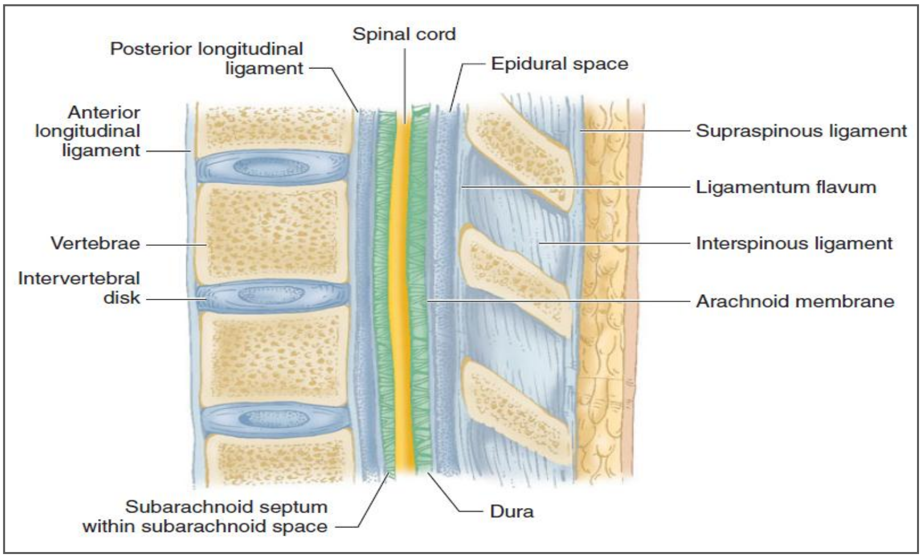


Figure 1: Common features of vertebrae. Sagittal section through lumbar vertebrae. (Adapted with permission, from Waxman SG: Correlative Neuroanatomy, 24th ed. McGraw-Hill, 2000.)

The atlas, the first cervical vertebra, lacks a body and has a unique articulation with the base of the skull and the second vertebra. The second vertebra, also called the axis, has atypical articulating surfaces. All 12 thoracic vertebrae articulate with their corresponding rib. Sacral vertebrae fuse into one large bone, the sacrum, but each one has separate anterior and posterior intervertebral foramina. Moreover, the lamina of S5 and parts or all of that of S4 normally don't fuse leaving a caudal opening to the spinal canal, the sacral hiatus. Coccygeal vertebrae are small rudimentary structures that also fused **(Figure 2) (Green et al., 2010).**

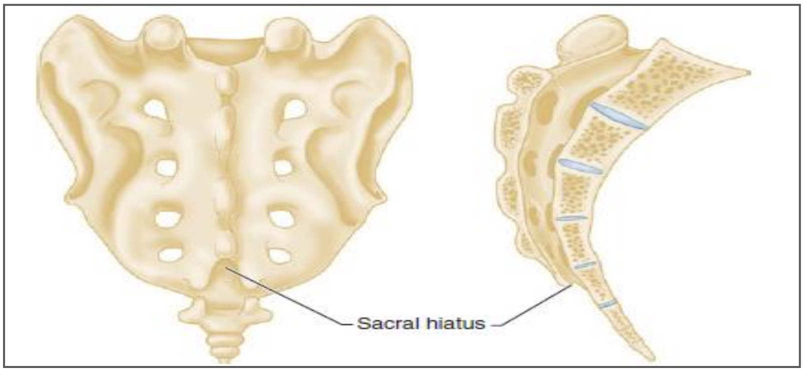


Figure 2: Posterior and saggital view of sacrum and coccyx. (Adapted with permission, from Waxman SG: Correlative Neuroanatomy, 24th ed.McGraw-Hill, 2000.)

The spinal column forms a double C, which is convex anteriorly in the cervical and lumbar regions **(Figure 3)**. Ligamentous elements provide structural support and with supporting muscles help in maintaining the unique shape. Anteriorly, the vertebral bodies and intervertebral discs are connected together and supported by the anterior and posterior longitudinal ligaments **(Figure 1)**. Posteriorly, the ligamentum flavum, interspinous ligament, and supraspinous ligament provide stability also **(Hebl et al., 2010).**

The spinal cord

The spinal canal contains the spinal cord with its meninges, venous plexus, and fatty tissue **(Figure 4)**. The meninges are composed of three layers: the pia mater, arachnoid mater, and the dura mater; all are continuous with their cranial counterparts. The pia mater is closely adherent to the spinal cord, while the arachnoid mater is closely adherent to the thicker and denser dura mater. Cerebrospinal fluid (CSF) is present in the subarachnoid space between the pia and arachnoid maters. The spinal subdural space is generally a poorly demarcated, potential space that exists between the dura and arachnoid membranes. The epidural space is a more defined potential space within the spinal canal which is bounded by ligamentum flavum and the dura (**Figure 5) (Reynolds et al., 2008).**

The spinal cord normally extends from the foramen magnum to the level of L1 in adult. In children, the spinal cord ends at L3 but moves up as they grow older. The anterior and posterior nerve roots at each spinal level join together and exit through the intervertebral foramina forming spinal nerves from C1 to S5 **(Figure 5) (Chin et al., 2011).**

At the cervical level, the nerves arise above their respective vertebra, but starting from T1 they exit below their vertebra. So, there are eight cervical nerve roots but seven cervical vertebrae only. Moreover, at the cervical and upper thoracic levels, the roots emerge from the spinal cord and exit the vertebral foramina nearly at the same level **(Figure 3)**. But because the spinal cord normally ends at L1, lower nerve roots travel an increasing distance (within the lumbar and sacral subarachnoid and epidural spaces) from the spinal cord to the intervertebral foramina. These lower spinal nerves form what is called the cauda equina **(Figure 3)**.Therefore, performing a lumbar (subarachnoid) puncture below L1 in an adult (L3 in a child) avoids trauma to the cord; damage to the cauda equina is unlikely because these nerve roots float in the dural sac below L1 and tend to be pushed away (rather than pierced) by an advancing needle **(Rukewe et al., 2010).**