Spinal Anesthesia In Neonates

An Essay

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Master Degree in Anesthesia Medicine

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List of Abbreviation

ACTH	Adrenocorticotropic hormone
ASA	American Society of Anesthesiologists
aPTT	Activated partial thromboplastin time
C	Cervical vertevra
cAMP	Cyclic adenosine monophosphate
CHEOPS	Children's Hospital of Eastern Ontario Pain Scale
CNS	Central nervous system
Co	Coccygeal vertebra
CSF	Cerebro spinal fluid
CVS	cardiovascular system
EMLA	Eutectic mixture of local anesthetics
fig.	Figure
GA	General anesthesia
GABA	Gamma-Aminobutyric acid
GHB	Gamma-Hydroxybutyrate
IgE	Immunoglobulin E
IV	Intravenous
K+	Potassium ions
kg.	Kilogram
L	Lumbar vertebra
µg	Microgram
min.	Minute

ml.	Milliliter
NMDA	N-methyl D-aspartate
PABA	Para amino benzoic acid
PDPH	Post dural puncture headache
Po2	Oxygen partial pressure
PONV	Post operative nausea and vomiting
PT	Prothrombin time
PTT	Partial thromboplastin time
S	Sacral vertebra
SA	Spinal anesthesia
SpO_2	Oxygen saturation
T	Thoracic vertebra
US	Ultrasound

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Miral Philip Henry Luka

Introduction

In pediatric practice, spinal anesthesia is used mainly for inguinal hernia repair in former preterm infants to reduce the risk of postoperative apnea. Infants born at less than 37 weeks gestational age and less than 60 weeks postconceptional age at the time of surgery are at risk for apnea after general anesthesia, those presenting with continuing apnea at home or anemia (hematocrit 30%) are at even greater risk, this complication appears to be reduced, though not eliminated, following spinal anesthesia without concomitant sedation ***(Santhanam and Melissa, 2002).***

In infants, the spinal cord ends at third lumbar vertebra (L3), the differences between adults and children are due to differential longitudinal growth of the spinal canal and the cord. ***Fitzgerald and colleagues*** stated that the spinal cord, early in fetal life, stretches through the whole vertebral canal with the nerve roots leaving the intervertebral foramina in a horizontal fashion, growth of the vertebral column causes the lower part of the spinal cord to ascend relative to the vertebrae as the upper end is attached to the brain, at 6 months of fetal life, the lowest limit of the spinal cord lies at the level of first sacral vertebra

(S1), at birth the conus medullaris is mostly found at the level of L3 ***(Boon et al., 2004).***

Spinal anesthesia may reduce the incidence of morbidity that follows general anesthesia in neonates and in former preterm infants. However, bupivacaine alone provides a block too short for complete surgery in up to 40% of the patients. Clonidine lengthens spinal anesthesia in adults and caudal block in children without significant side effects ***(Alain et al., 2004).***

Spinal anesthesia in infants is associated with a very infrequent incidence of complications, such as hypoxemia, bradycardia, and postoperative apnea, although spinal anesthesia would seem to be a logical alternative to general anesthesia for many surgical procedures, it remains an underutilized technique ***(Robert et al., 2006).***

The anesthesia technique of choice in all infants below 7 month of age undergoing lower abdominal, perineal, urological and lower extremity procedures lasting less than 90 minutes, is spinal anesthesia. Contraindications include presence of coagulopathy or generalized sepsis, evidence of infection or congenital malformations at the place of puncture, mechanical ventilation and parental refusal ***(Kachko et al., 2007).***

Aim of the Work

The purpose of this study is to review the spinal anesthesia in neonates, different techniques, advantages, disadvantages and complications.

Anatomical and Physiological Considerations

Anatomy of the spinal cord

The spinal cord is the long bundle of nerves and neurons that runs down the middle of the back. It is enclosed in the vertebral column (spine) and is considered part of the central nervous system (CNS) which regulates sensory inflow and contributes to the control of movements. The spinal cord looks and often functions like a cable bringing sensory information from the body to the brain and sending movement commands from the brain to the body. In addition, the spinal cord processes sensory and motor signals ***(Muller, 2008).***

A. Gross anatomy of the spinal cord

The spinal cord is present in the vertebral canal inside the vertebral column **(Fig. 1)**, it is symmetric in the midline and labeled for associated vertebrae. There are five groups of vertebrae: cervical (C), thoracic (T), lumbar (L), sacral (S) and coccygeal (Co). There are 31 pairs of afferent and efferent spinal nerves that branch outside the vertebral column to form peripheral nerves. Each level of the cord receives somatic sensory information from, and sends somatic motor commands to a specific part of the body. In addition, the T1-L2 segments include sympathetic neurons and the S1-S5 segments contain parasympathetic neurons. Because the spinal cord stops growing earlier in development than the rest of the body, the cord is shorter than the vertebral column, it ends at L1 in adults, below which the vertebral canal contains only dorsal and ventral roots. Dorsal and ventral roots join after the dorsal root ganglion to form spinal nerves that exit the vertebral column at the associated vertebral level. Below the cervical segments the nerve roots travel more and more caudally to reach their exit points ***(Muller, 2008).***

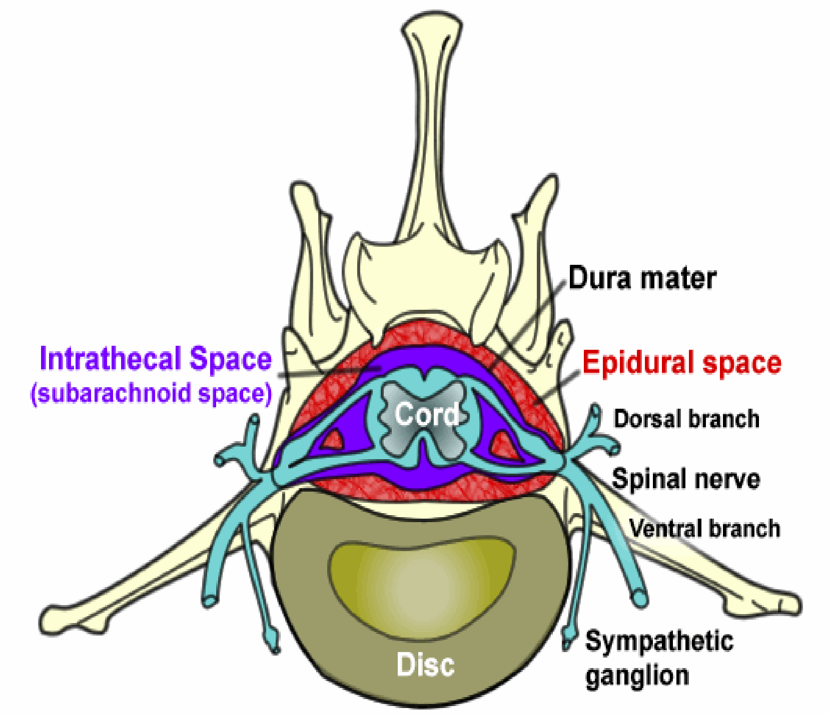

Figure 1: The spinal cord rests in the spinal canal inside the vertebral column ***(Muller, 2008).***

B. Cross Sectional Anatomy

Spinal gray matter which is composed of cell bodies is arranged in an "H" pattern inside white matter (composed of axons), which is functionally arranged in the sensorydorsal, motor-ventral organization that is fairly consistent throughout the brainstem. The intermediate section of gray matter is filled, mainly, with interneurons **(fig. 2)**. Somatosensory information enters the cord through primary afferent axons in dorsal roots. Cell bodies of these neurons are in the dorsal root ganglia, branches of these axons synapse in the ipsilateral dorsal horns ***(Muller, 2008).***

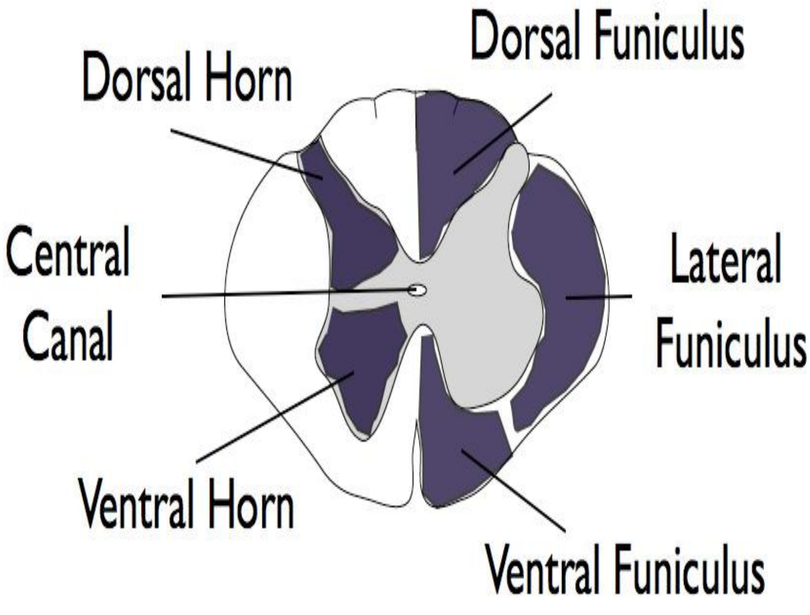

Figure 2: A diagram of the major spinal cord features ***(Muller, 2008).***

Axons of motorneurons leave the cord through ventral roots to contract ipsilateral muscles. Motorneuron cell bodies are in the ventral horns, motorneurons for axial muscles are in the medial ventral horn, while those for distal muscles are in the lateral ventral horn. Cord cross section looks different at different segments, cervical and lumbar segments are enlarged because they contain sensory neurons, motorneurons and interneurons related to the arms and legs, respectively. There is a rostral-to-caudal decrease in the amount of white matter because each level of the cord contains the fibers ascending from, and descending to more caudal segments ***(Muller, 2008).***

In Infants, the spinal cord ends at L3 **(fig. 3)**. Needle placement should therefore be at L4/5 or L5/S1. The anatomical differences between adults and children are due to differential longitudinal growth of the spinal canal and the cord. At the sixth month of fetal life, the lowest limit of the spinal cord lies at the level of S1. At birth the conus medullaris is mostly found at the level of L3 ***(Boon et al., 2004).***

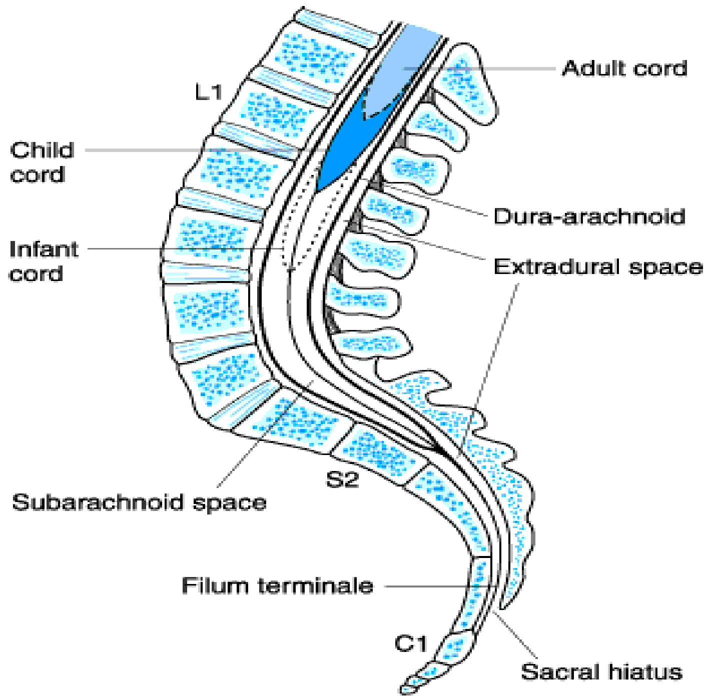

Figure 3: Sagittal view through the lumbar vertebrae and sacrum ***(Morgan et al., 2006).***

The end of the spinal cord rises with development from approximately L3 to L1. The dural sac normally ends at S2 ***(Morgan et al., 2006).***

The most obvious difference between children and adults pertains to body size. Normal full-term neonates weigh 3 to 3.5 kg with a height of 50 cm, and within 10 to 15 years they will multiply their weight by more than 12 (>1200%) and their height by more than 3 (>300%). During the early stages of development, the spinal cord occupies the spinal canal entirely,